CENTER FOR THE COMMERCIAL DEPLOYMENT OF TRANSPORTATION TECHNOLOGIES (CCDoTT)
California State University, Long Beach

January 18, 2007

Dr. Paul Rispin, Program Manager
Office of Naval Research, Code 331
875 North Randolph Street, Room 273
Arlington, VA 22203-1995

Subject: Deliverable Number 0015, Collaborative Toolkit System Documentation and User Manual: The TRANSWAY Toolset for Adaptive Planning

Reference: Strategic Mobility 21 Contract N00014-06-C-0060

Dear Paul,

In accordance with the requirements of referenced contract, we are pleased to submit this Collaborative Toolkit System Documentation and User Manual: The TRANSWAY Toolset for Adaptive Planning for your review.

Your comments on this document are welcomed.

Regards,

Dr. Lawrence G. Mallon
Strategic Mobility 21 Program Manager

cc: Administrative Contracting Officer (Transmittal Letter only)
Director, Naval Research Lab (Hardcopy via U.S. Mail)
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Strategic Mobility 21

Collaborative Toolkit System Documentation & User Manual:

The TRANSWAY Toolset for Adaptive Planning

Contractor Report 0015

Prepared for:

Office of Naval Research
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In fulfillment of the requirements for:

FY 2005 Contract No. N00014-06-C-0060
Strategic Mobility 21 – CLIN 0015

Prepared and Submitted by:

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November 30, 2006

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Abstract

This report describes the capabilities of the TRANSWAY suite of tools in the logistical domain. It addresses in particular their suitability for supporting an end-to-end military deployment exercise that is scheduled to occur within the Southern California public transportation corridor sometime in the first half of 2007. In support of this planned exercise the ontology-based intelligent agents of the TRANSWAY adaptive toolset will be able to assist operators in the planning and re-planning of delivery plans along alternative surface routes and air channels within a geo-spatial reference frame.

TRANSWAY User Guide

Executive Summary Description

Background: The deployment and distribution responsibilities of USTRANSCOM call for intelligent collaborative tools in support of strategic and operational planning functions involving the sustainment and movement of forces. The sustainment requirement is generated at the operational level and is dynamic. It is composed of shifting priorities responding to changes in commander's intent and changes in the operational situation. However, while commander's intent and future plans normally drive the sustainment requirement, it is also possible for the reverse to occur. Unit movement and sustainment flow planning and execution monitoring is largely planned and executed at the strategic level, responding to ship and aircraft availability and other gross transportation factors only indirectly related to the changing operational priorities in the theater. Strategic flow planning and execution processes are focused on logistic efficiency and tonnage, while satisfying operational requirements is focused on logistic effectiveness (i.e., providing the right thing in the right quantity at the right place at the right time to the right units).

Functional Capabilities: TRANSWAY is designed as a set of intelligent collaborative tools supporting operators performing planning and re-planning tasks in a dynamically changing decision-making environment. The open, service-oriented architecture of TRANSWAY allows these capabilities to be progressively extended, to include:

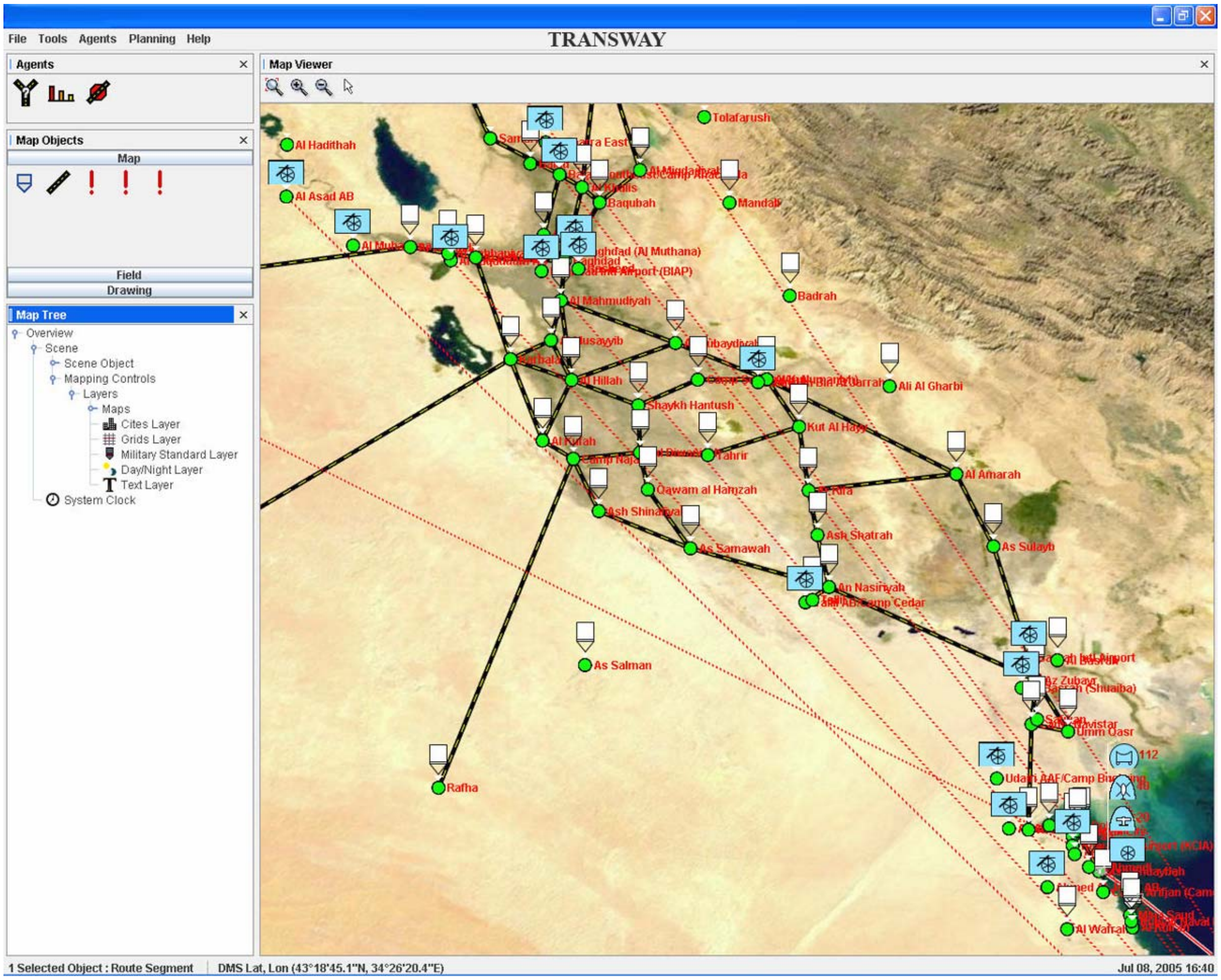
- Intelligent decision-support tools that detect changing sustainment priorities and automatically generate options that integrate transport assets, inventory availability, and on-going operations.
- Intelligent decision-support tools that are capable of integrating theater infrastructure capacities and characteristics (as well as changes to these) into sustainment and distribution plans, and projections.
- Intelligent decision-support tools that ensure continuous visibility of both the dynamic sustainment requirements and the strategic sustainment plans generated in response to these requirements.

Underlying Ontology: The TRANSWAY ontology is divided into logical domains that can be described using the Unified Modeling Language (UML) methodology. Within each domain exist definitions of the various concepts and entities relevant to the representation and analysis of key aspects of each domain. Classes located within package symbols are defined within that domain. These classes may relate to classes defined in other domains through either *inheritance* or *associations*. In both cases, referenced classes are identified by their symbols existing outside the primary package symbol with some type of relationship symbol connecting them to package elements. Domains themselves may be related to each other in either a sibling or parent/child relationship. Such connections are an indication of the particular scope and inter-domain visibility.

Intelligent Agents: TRANSWAY includes two kinds of agents with strategic and operational planning and re-planning capabilities, respectively. The strategic planning agents are based on the Tabu genetic search algorithm and the operational planning agents are rule-based and implemented in Java.

Tabu Search is a local search method for exploring a solution space. In the TRANSWAY implementation of the Tabu genetic algorithm the solution space is every possible planning recommendation. Starting from an initial empty plan, new plans are generated and immediately evaluated based on a merit function. The highest rated plan then becomes the new incumbent best solution, followed by a repetition of the same procedure. Once some ending criterion has been reached the algorithm may stop and report the best solution that it has found or, as in the current version of TRANSWAY, reporting may occur on a continuous basis as better and better solutions are found.

The Re-Planning Agent prepares plans for the delivery of cargo to the required destinations and re-plans when necessary. It makes use of the ICDM-Hibernate library in order to be a collaborative component of the TRANSWAY system. Planning and re-planning sequences proceed in three basic steps, as follows: (1) extraction of the current problem domain model from the ontology; (2) preparation of a solution plan that does not violate any of the logistical constraints; and, (3) injection of the problem domain model of the solution plan back into the ontology.



Development Stage: The development of TRANSWAY commenced in October 2004 under sponsorship of USTRANSCOM (J6). An initial test-bed application environment was demonstrated in April 2005. TRANSWAY Version 1 is scheduled for delivery with a web-based user-interface and subsequent field testing in December 2006.

Further Information: Jens Pohl, CTO CDM Technologies, Inc. (805-756-2841; jpohl@cdmtech.com)

Comprehensive TRANSWAY Scenario

The main TRANSWAY screen (Figure 1) is divided into two principal areas. On the left side, moving from the top down, below the main option bar the user will find: three agent icons; objects that may be placed on top of the map (the right side of the screen); a tree-structure that provides quick and convenient access to the data that the system is currently populated with; and, at the bottom a command window for the Tabu agent. On the right side of the screen is a geo-referenced map that allows the user to pan to any part of the world and, subject to the availability of maps, zoom down to street level if desired. Objects representing nodes (e.g., SAAs, APODs, etc.), route segments, impediments, and areas of interest may be moved from the left side of the screen to the right side by simple *click to locate* actions. Alternatively, the user may specify latitude-longitude locations and the selected object will be automatically placed on the map in the correct location. These objects, whether entered by the user or pre-initialized in the system, have attributes that relate to TRANSWAY's internal ontology and provide the necessary context for automated agent actions.

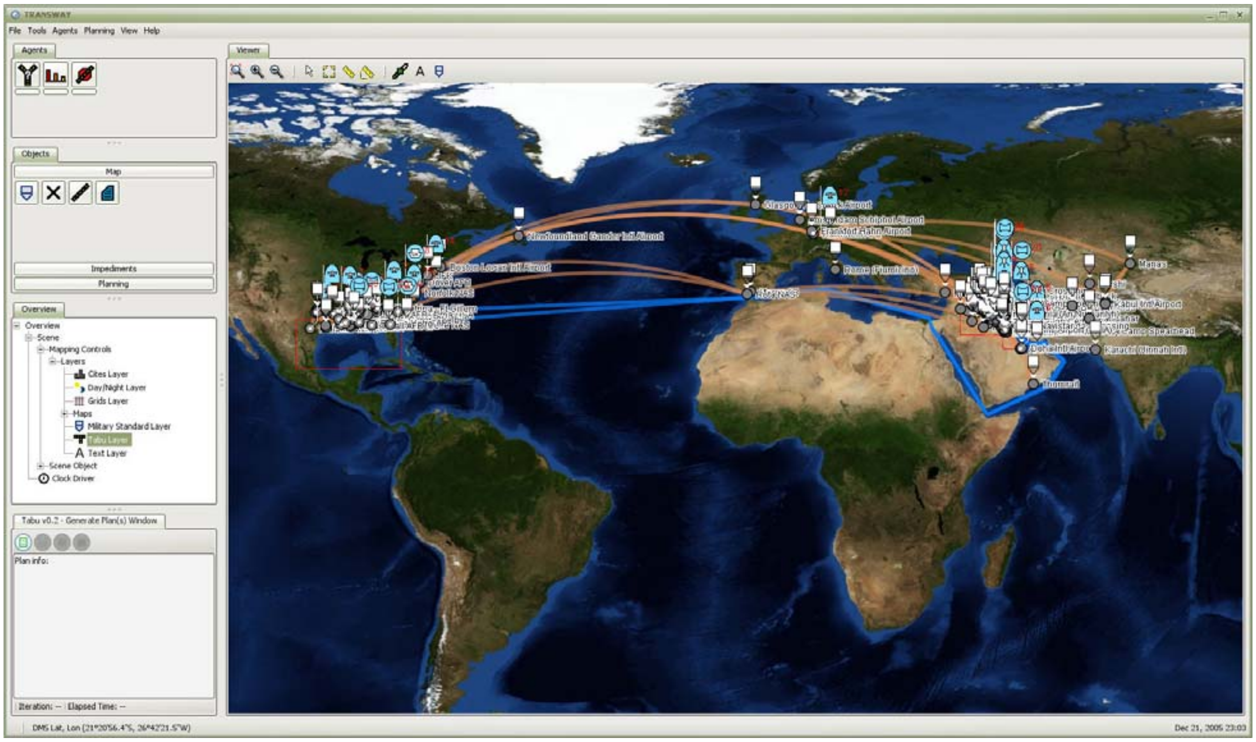


Figure 1: Main TRANSWAY screen

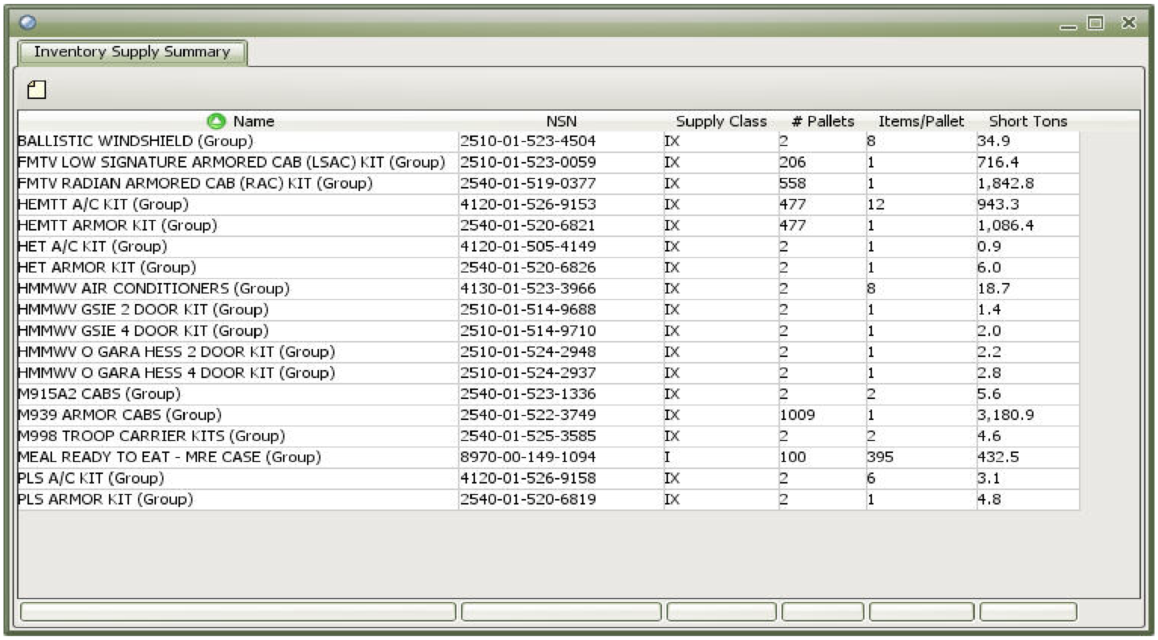
TRANSWAY is by no means limited to the current set of attributes. With the contractual goal of this first version of a prototype system to demonstrate the typical capabilities of an ontology-based multi-agent system, attributes were selected in a fairly generic fashion based on the feedback that the development team received during early demonstrations, perusal of military documents, and in-house experience with other logistic planning systems such as the Integrated Computerized Deployment System (ICODES) and the Joint Forces Collaborative Toolkit (JFCT).

Supply Center Summary

Supply Center	MOG Parking	MOG Working	Throughput	Short T...	Fixed Wing	Rotary Wing	Vessels	Vehicles
Charleston AFB	15	10	0.0	8,289.2	15	0	8	0
Dover AFB	15	10	0.0	4,361.3	14	0	0	0
Ramstein AFB	15	10	0.0	966.1	17	0	0	0
Ash Shuaybah	20	10	0.0	966.1	0	0	0	24
Kuwait Intl Airport (KCIA)	6	5	0.0	966.1	4	5	0	20
Al Taqaddum AB	2	2	0.0	966.1	0	4	0	10
Al Udeid AB	2	2	0.0	966.1	8	5	0	0
Bagram AB	2	2	0.0	966.1	0	0	0	0
Balad Southeast/Camp Anaconda	2	2	0.0	966.1	1	7	0	16
Kandahar	2	2	0.0	966.1	0	0	0	0
Barksdale AFB	15	10	0.0	432.5	7	0	0	0
JTF Katrina - Ft Gillem	10	6	0.0	432.5	7	0	0	0
Kelly/Lackland	10	6	0.0	432.5	7	0	0	0
Fort Worth NAS	15	6	0.0	432.5	7	0	0	0
Jacksonville NAS	0	0	0.0	57.7	0	0	6	0
Dallas-FT Worth IAP	15	10	0.0	0.0	0	0	0	0
England AFB	15	10	0.0	0.0	0	0	0	0
George Bush IAP	15	10	0.0	0.0	0	0	0	0
Glasgow Prestwick Airport	15	10	0.0	0.0	0	0	0	0
JFK	15	10	0.0	0.0	0	0	0	0
Maxwell AFB	15	10	0.0	0.0	0	0	0	0
Newfoundland Gander Intl Airport	15	10	0.0	0.0	0	0	0	0
Tydall AFB	15	10	0.0	0.0	0	0	0	20
Mobile Regional AP	10	6	0.0	0.0	0	0	0	20
NAS Meridian	10	6	0.0	0.0	0	0	0	0
Rota NAS	10	6	0.0	0.0	0	0	0	0
William P. Hobby	10	6	0.0	0.0	0	0	0	0
Camp Najaf	10	5	0.0	0.0	0	0	0	0
Camp Navistar	10	5	0.0	0.0	0	0	0	0
Camp Scania (An Numanlyh)	10	5	0.0	0.0	0	0	0	0
Louis Armstrong IAP	0	4	0.0	0.0	0	0	0	0
Al Asad AB	5	3	0.0	0.0	0	0	0	0
Baton Rouge Metro	5	3	0.0	0.0	0	0	0	20
Ellington, TX	5	3	0.0	0.0	0	0	0	0
Gulf Port IAP	5	3	0.0	0.0	0	0	0	0
JTF FWD - Camp Shelby	5	3	0.0	0.0	0	0	0	20
Karshi	5	3	0.0	0.0	0	0	0	0
Lafayette IAP	5	3	0.0	0.0	0	0	0	20
Manas	5	3	0.0	0.0	0	0	0	0
Thumrait	5	3	0.0	0.0	0	0	0	0
Kessler AFB	0	2	0.0	0.0	0	0	0	0
Al Sahra AB/Camp Speicher	3	2	0.0	0.0	0	0	0	0
Al Qayyarah West	4	2	0.0	0.0	0	0	0	0
Herat	4	2	0.0	0.0	0	0	0	0
Kirkuk AB	4	2	0.0	0.0	0	4	0	0
Mosul AB/Camp Diamondback	4	2	0.0	0.0	0	0	0	0
Tallil AB/Camp Cedar	4	2	0.0	0.0	0	0	0	0
Ali Al Salem AB	2	1	0.0	0.0	0	0	0	0
Baghdad Intl Airport (BIAP)	2	1	0.0	0.0	2	8	0	20
Kabul Intl Airport	4	1	0.0	0.0	0	0	0	0
Ad Diwaniyah	0	0	0.0	0.0	0	0	0	0

Figure 2: Summary of supplies and available conveyances at supply centers

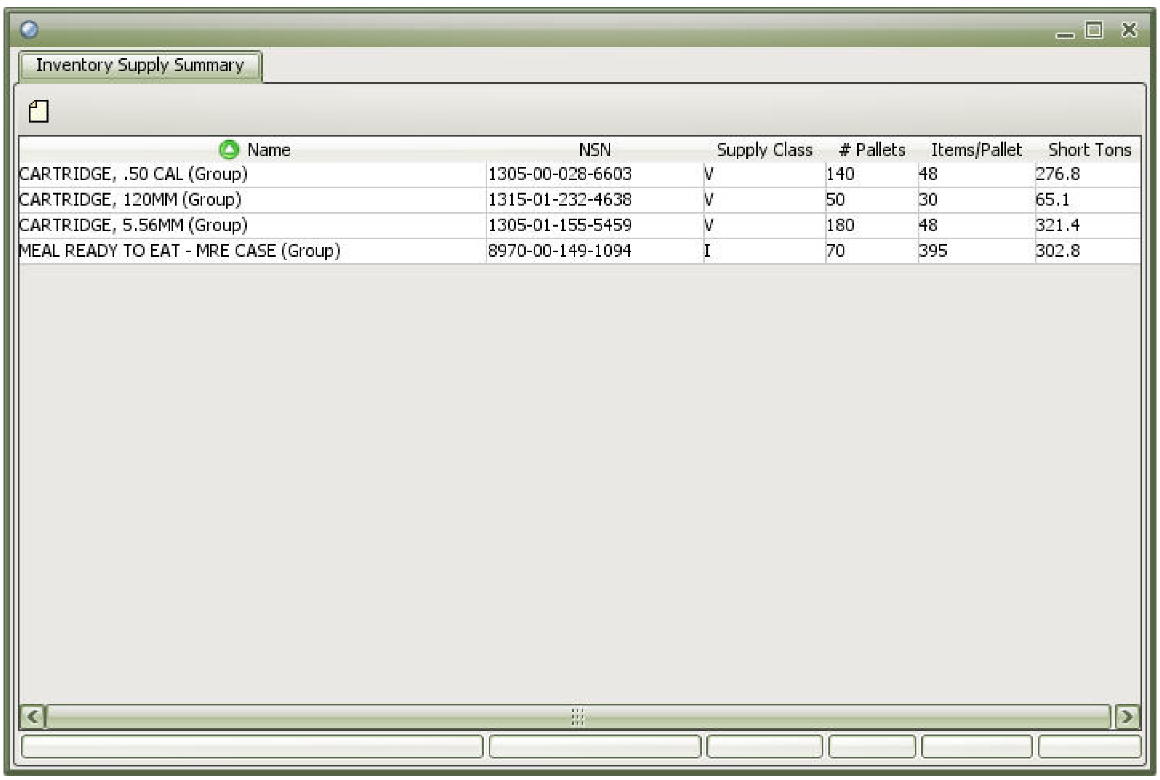
The report shown in Figure 2 provides a summary of supplies (short tons) and available conveyances (i.e., fixed wing aircraft, helicopters, ships, and trucks (in convoys)) at most supply centers currently initialized in the system for this particular demonstration scenario. Details of supplies at Charleston and Al Udeid are shown in Figures 3 and 4 (in terms of supply Class, number of pallets, number of items per pallet, and short tons), respectively.



Inventory Supply Summary

Name	NSN	Supply Class	# Pallets	Items/Pallet	Short Tons
BALLISTIC WINDSHIELD (Group)	2510-01-523-4504	IX	2	8	34.9
FMTV LOW SIGNATURE ARMORED CAB (LSAC) KIT (Group)	2510-01-523-0059	IX	206	1	716.4
FMTV RADIAN ARMORED CAB (RAC) KIT (Group)	2540-01-519-0377	IX	558	1	1,842.8
HEMTT A/C KIT (Group)	4120-01-526-9153	IX	477	12	943.3
HEMTT ARMOR KIT (Group)	2540-01-520-6821	IX	477	1	1,086.4
HET A/C KIT (Group)	4120-01-505-4149	IX	2	1	0.9
HET ARMOR KIT (Group)	2540-01-520-6826	IX	2	1	6.0
HMMWV AIR CONDITIONERS (Group)	4130-01-523-3966	IX	2	8	18.7
HMMWV GSIE 2 DOOR KIT (Group)	2510-01-514-9688	IX	2	1	1.4
HMMWV GSIE 4 DOOR KIT (Group)	2510-01-514-9710	IX	2	1	2.0
HMMWV O GARA HESS 2 DOOR KIT (Group)	2510-01-524-2948	IX	2	1	2.2
HMMWV O GARA HESS 4 DOOR KIT (Group)	2510-01-524-2937	IX	2	1	2.8
M915A2 CABS (Group)	2540-01-523-1336	IX	2	2	5.6
M939 ARMOR CABS (Group)	2540-01-522-3749	IX	1009	1	3,180.9
M998 TROOP CARRIER KITS (Group)	2540-01-525-3585	IX	2	2	4.6
MEAL READY TO EAT - MRE CASE (Group)	8970-00-149-1094	I	100	395	432.5
PLS A/C KIT (Group)	4120-01-526-9158	IX	2	6	3.1
PLS ARMOR KIT (Group)	2540-01-520-6819	IX	2	1	4.8

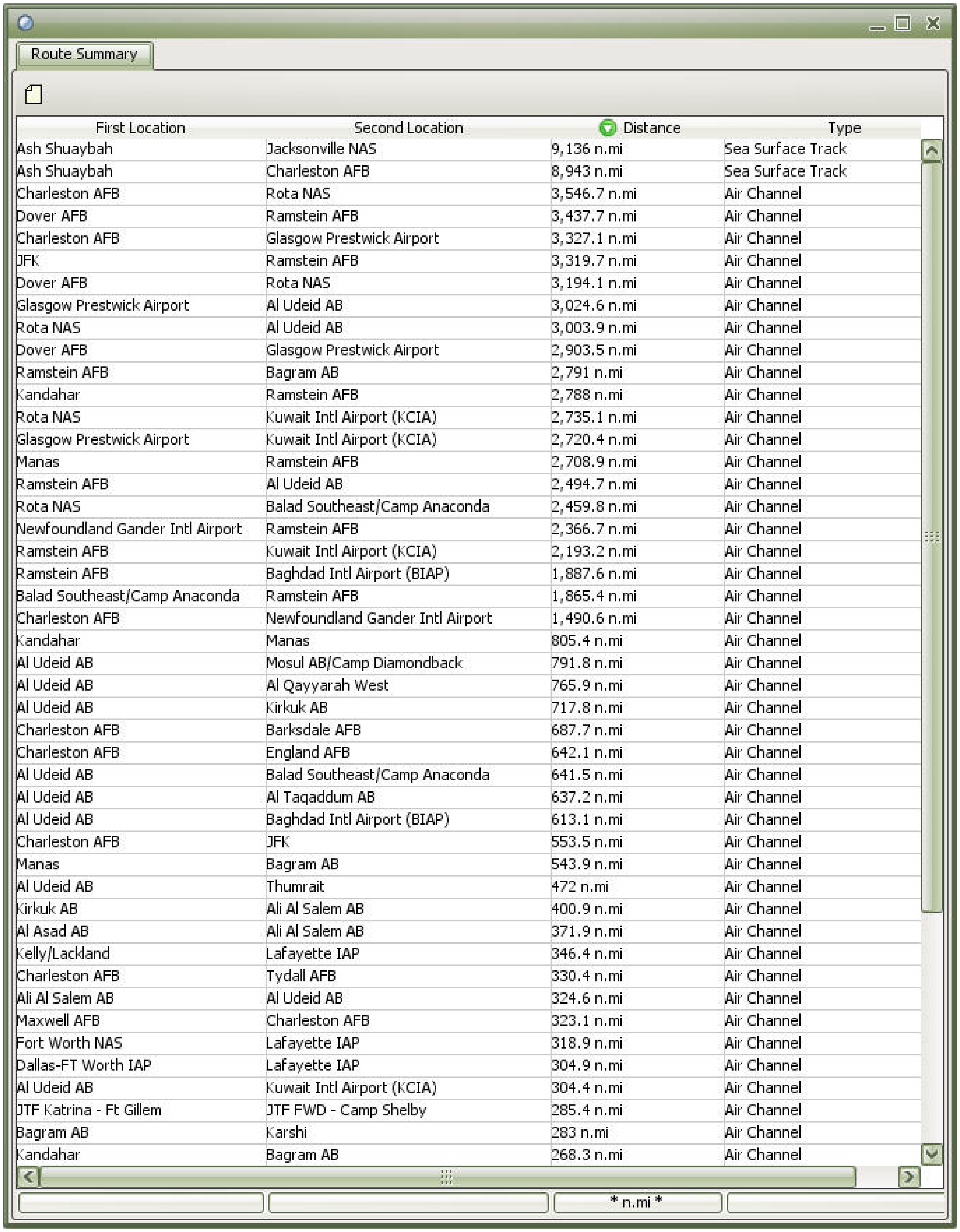
Figure 3: Details of supplies at Charleston



Inventory Supply Summary

Name	NSN	Supply Class	# Pallets	Items/Pallet	Short Tons
CARTRIDGE, .50 CAL (Group)	1305-00-028-6603	V	140	48	276.8
CARTRIDGE, 120MM (Group)	1315-01-232-4638	V	50	30	65.1
CARTRIDGE, 5.56MM (Group)	1305-01-155-5459	V	180	48	321.4
MEAL READY TO EAT - MRE CASE (Group)	8970-00-149-1094	I	70	395	302.8

Figure 4: Details of supplies at Al Udeid



Route Summary

First Location	Second Location	Distance	Type
Ash Shuaybah	Jacksonville NAS	9,136 n.mi	Sea Surface Track
Ash Shuaybah	Charleston AFB	8,943 n.mi	Sea Surface Track
Charleston AFB	Rota NAS	3,546.7 n.mi	Air Channel
Dover AFB	Ramstein AFB	3,437.7 n.mi	Air Channel
Charleston AFB	Glasgow Prestwick Airport	3,327.1 n.mi	Air Channel
JFK	Ramstein AFB	3,319.7 n.mi	Air Channel
Dover AFB	Rota NAS	3,194.1 n.mi	Air Channel
Glasgow Prestwick Airport	Al Udeid AB	3,024.6 n.mi	Air Channel
Rota NAS	Al Udeid AB	3,003.9 n.mi	Air Channel
Dover AFB	Glasgow Prestwick Airport	2,903.5 n.mi	Air Channel
Ramstein AFB	Bagram AB	2,791 n.mi	Air Channel
Kandahar	Ramstein AFB	2,788 n.mi	Air Channel
Rota NAS	Kuwait Intl Airport (KCIA)	2,735.1 n.mi	Air Channel
Glasgow Prestwick Airport	Kuwait Intl Airport (KCIA)	2,720.4 n.mi	Air Channel
Manas	Ramstein AFB	2,708.9 n.mi	Air Channel
Ramstein AFB	Al Udeid AB	2,494.7 n.mi	Air Channel
Rota NAS	Balad Southeast/Camp Anaconda	2,459.8 n.mi	Air Channel
Newfoundland Gander Intl Airport	Ramstein AFB	2,366.7 n.mi	Air Channel
Ramstein AFB	Kuwait Intl Airport (KCIA)	2,193.2 n.mi	Air Channel
Ramstein AFB	Baghdad Intl Airport (BIAP)	1,887.6 n.mi	Air Channel
Balad Southeast/Camp Anaconda	Ramstein AFB	1,865.4 n.mi	Air Channel
Charleston AFB	Newfoundland Gander Intl Airport	1,490.6 n.mi	Air Channel
Kandahar	Manas	805.4 n.mi	Air Channel
Al Udeid AB	Mosul AB/Camp Diamondback	791.8 n.mi	Air Channel
Al Udeid AB	Al Qayyarah West	765.9 n.mi	Air Channel
Al Udeid AB	Kirkuk AB	717.8 n.mi	Air Channel
Charleston AFB	Barksdale AFB	687.7 n.mi	Air Channel
Charleston AFB	England AFB	642.1 n.mi	Air Channel
Al Udeid AB	Balad Southeast/Camp Anaconda	641.5 n.mi	Air Channel
Al Udeid AB	Al Taqaddum AB	637.2 n.mi	Air Channel
Al Udeid AB	Baghdad Intl Airport (BIAP)	613.1 n.mi	Air Channel
Charleston AFB	JFK	553.5 n.mi	Air Channel
Manas	Bagram AB	543.9 n.mi	Air Channel
Al Udeid AB	Thumrait	472 n.mi	Air Channel
Kirkuk AB	Ali Al Salem AB	400.9 n.mi	Air Channel
Al Asad AB	Ali Al Salem AB	371.9 n.mi	Air Channel
Kelly/Lackland	Lafayette IAP	346.4 n.mi	Air Channel
Charleston AFB	Tydall AFB	330.4 n.mi	Air Channel
Ali Al Salem AB	Al Udeid AB	324.6 n.mi	Air Channel
Maxwell AFB	Charleston AFB	323.1 n.mi	Air Channel
Fort Worth NAS	Lafayette IAP	318.9 n.mi	Air Channel
Dallas-FT Worth IAP	Lafayette IAP	304.9 n.mi	Air Channel
Al Udeid AB	Kuwait Intl Airport (KCIA)	304.4 n.mi	Air Channel
JTF Katrina - Ft Gillem	JTF FWD - Camp Shelby	285.4 n.mi	Air Channel
Bagram AB	Karshi	283 n.mi	Air Channel
Kandahar	Bagram AB	268.3 n.mi	Air Channel
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Figure 5: Summary report of air channels and sea routes

Figure 5 provides information about the air channels and sea routes that the system has been initialized with for this particular demonstration scenario. In each case the two end-points and the distance in nautical miles is indicated.

Detailed information about the current compliment of conveyances can be obtained by selecting the appropriate report. Typical examples for various fixed wing aircraft, trucks and ships are shown in Figures 6 to 11, below. The reason that the *speed* and *bearing* attributes in each table are zero is because the conveyances are not currently in-transit.

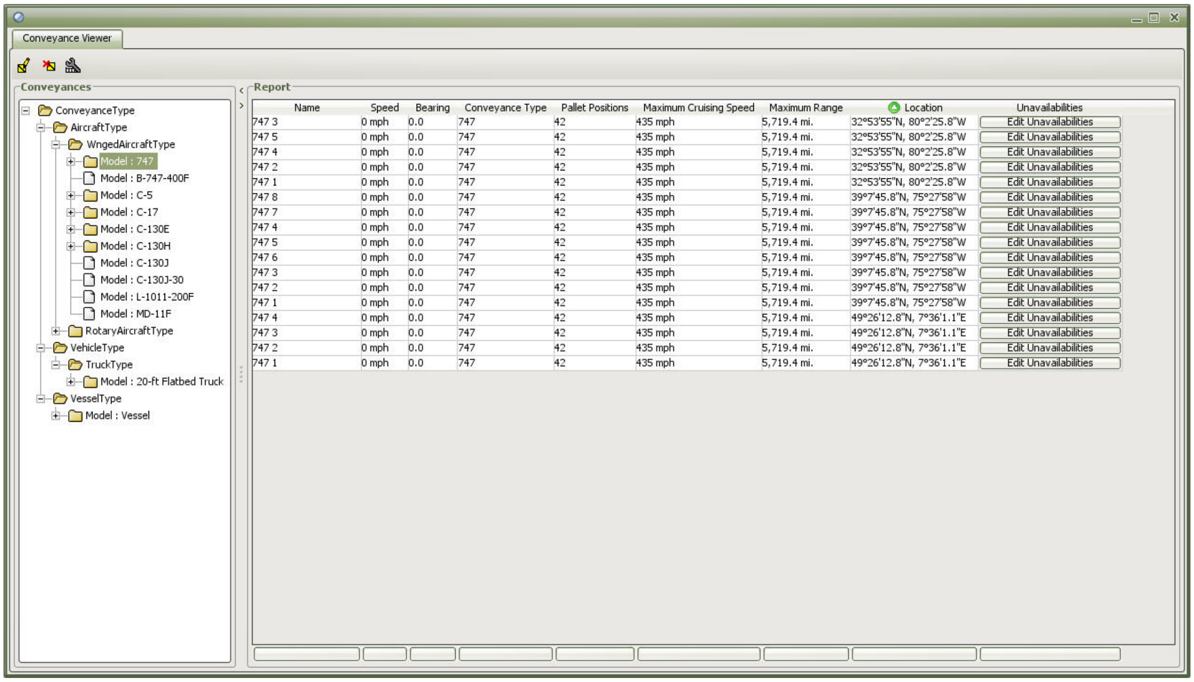


Figure 6: Boeing 747 aircraft attributes

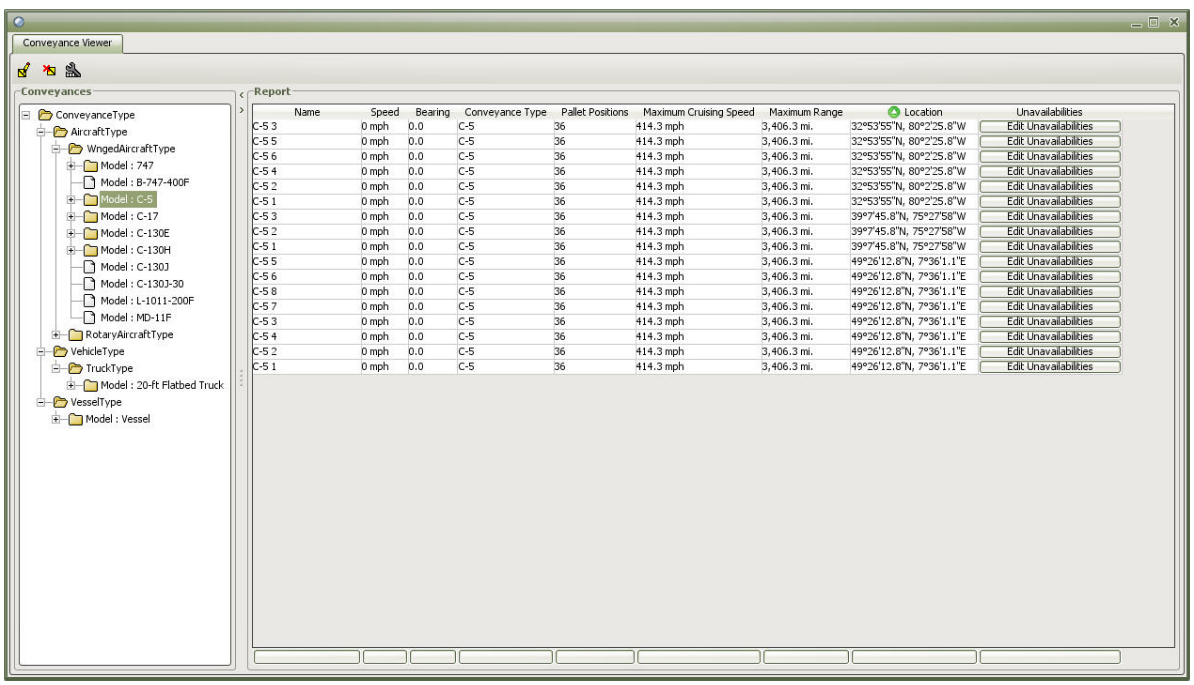
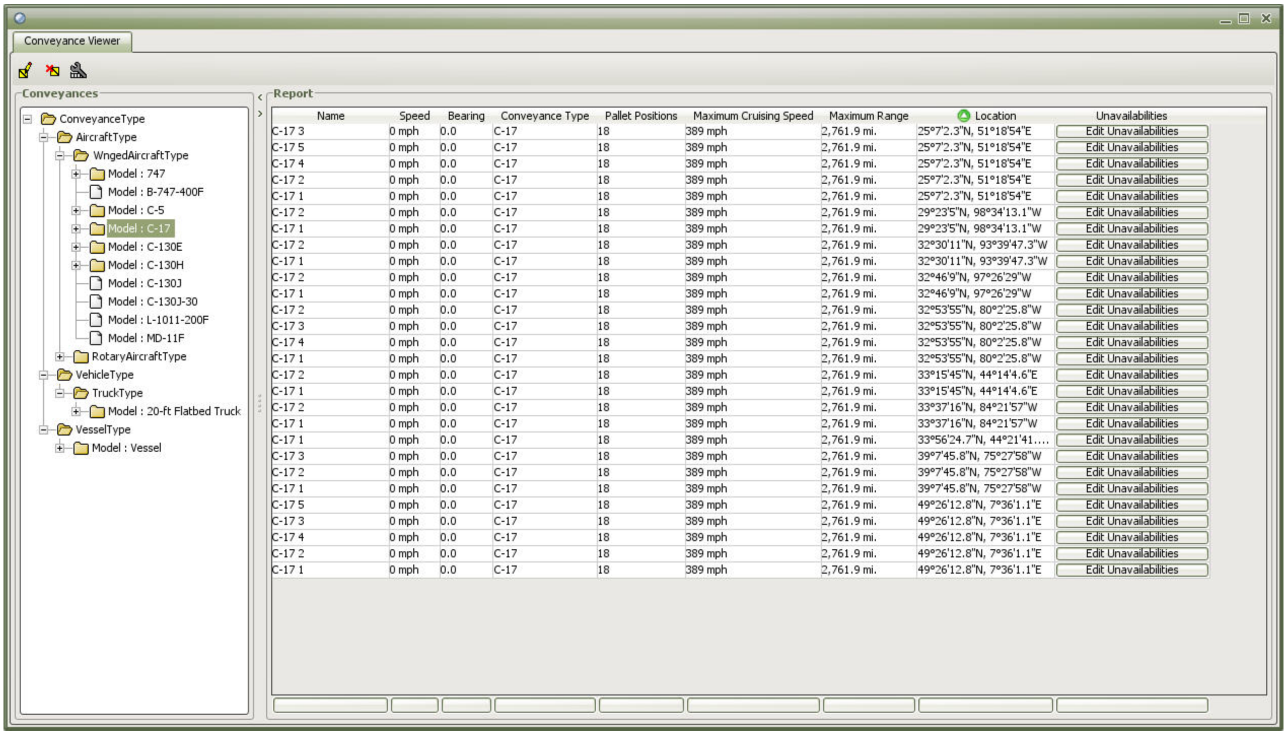
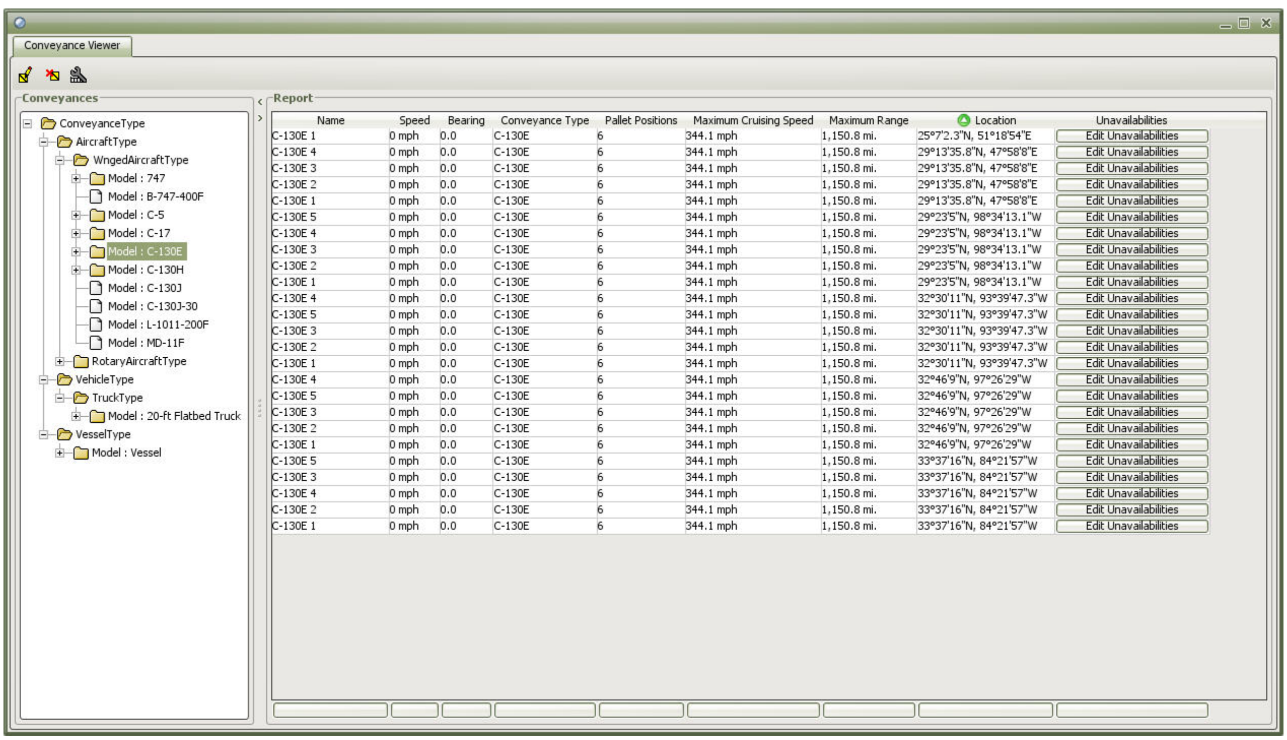


Figure 7: C5 aircraft attributes



Name	Speed	Bearing	Conveyance Type	Pallet Positions	Maximum Cruising Speed	Maximum Range	Location	Unavailabilities
C-17 3	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	25°7'2.3"N, 51°18'54"E	Edit Unavailabilities
C-17 5	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	25°7'2.3"N, 51°18'54"E	Edit Unavailabilities
C-17 4	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	25°7'2.3"N, 51°18'54"E	Edit Unavailabilities
C-17 2	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	25°7'2.3"N, 51°18'54"E	Edit Unavailabilities
C-17 1	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	25°7'2.3"N, 51°18'54"E	Edit Unavailabilities
C-17 2	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	29°23'5"N, 98°34'13.1"W	Edit Unavailabilities
C-17 1	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	29°23'5"N, 98°34'13.1"W	Edit Unavailabilities
C-17 2	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	32°30'11"N, 93°39'47.3"W	Edit Unavailabilities
C-17 1	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	32°30'11"N, 93°39'47.3"W	Edit Unavailabilities
C-17 2	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	32°46'9"N, 97°26'29"W	Edit Unavailabilities
C-17 1	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	32°46'9"N, 97°26'29"W	Edit Unavailabilities
C-17 2	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	32°53'55"N, 80°2'25.8"W	Edit Unavailabilities
C-17 3	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	32°53'55"N, 80°2'25.8"W	Edit Unavailabilities
C-17 4	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	32°53'55"N, 80°2'25.8"W	Edit Unavailabilities
C-17 1	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	32°53'55"N, 80°2'25.8"W	Edit Unavailabilities
C-17 2	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	33°15'45"N, 44°14'4.6"E	Edit Unavailabilities
C-17 1	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	33°15'45"N, 44°14'4.6"E	Edit Unavailabilities
C-17 2	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	33°37'16"N, 84°21'57"W	Edit Unavailabilities
C-17 1	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	33°37'16"N, 84°21'57"W	Edit Unavailabilities
C-17 1	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	33°56'24.7"N, 44°21'41....	Edit Unavailabilities
C-17 3	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	39°7'45.8"N, 75°27'58"W	Edit Unavailabilities
C-17 2	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	39°7'45.8"N, 75°27'58"W	Edit Unavailabilities
C-17 1	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	39°7'45.8"N, 75°27'58"W	Edit Unavailabilities
C-17 5	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	49°26'12.8"N, 7°36'1.1"E	Edit Unavailabilities
C-17 3	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	49°26'12.8"N, 7°36'1.1"E	Edit Unavailabilities
C-17 4	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	49°26'12.8"N, 7°36'1.1"E	Edit Unavailabilities
C-17 2	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	49°26'12.8"N, 7°36'1.1"E	Edit Unavailabilities
C-17 1	0 mph	0.0	C-17	18	389 mph	2,761.9 mi.	49°26'12.8"N, 7°36'1.1"E	Edit Unavailabilities

Figure 8: C17 aircraft attributes



Name	Speed	Bearing	Conveyance Type	Pallet Positions	Maximum Cruising Speed	Maximum Range	Location	Unavailabilities
C-130E 1	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	25°7'2.3"N, 51°18'54"E	Edit Unavailabilities
C-130E 4	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	29°13'35.8"N, 47°58'8"E	Edit Unavailabilities
C-130E 3	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	29°13'35.8"N, 47°58'8"E	Edit Unavailabilities
C-130E 2	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	29°13'35.8"N, 47°58'8"E	Edit Unavailabilities
C-130E 1	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	29°13'35.8"N, 47°58'8"E	Edit Unavailabilities
C-130E 5	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	29°23'5"N, 98°34'13.1"W	Edit Unavailabilities
C-130E 4	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	29°23'5"N, 98°34'13.1"W	Edit Unavailabilities
C-130E 3	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	29°23'5"N, 98°34'13.1"W	Edit Unavailabilities
C-130E 2	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	29°23'5"N, 98°34'13.1"W	Edit Unavailabilities
C-130E 1	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	29°23'5"N, 98°34'13.1"W	Edit Unavailabilities
C-130E 4	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	32°30'11"N, 93°39'47.3"W	Edit Unavailabilities
C-130E 5	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	32°30'11"N, 93°39'47.3"W	Edit Unavailabilities
C-130E 3	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	32°30'11"N, 93°39'47.3"W	Edit Unavailabilities
C-130E 2	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	32°30'11"N, 93°39'47.3"W	Edit Unavailabilities
C-130E 1	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	32°30'11"N, 93°39'47.3"W	Edit Unavailabilities
C-130E 4	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	32°46'9"N, 97°26'29"W	Edit Unavailabilities
C-130E 5	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	32°46'9"N, 97°26'29"W	Edit Unavailabilities
C-130E 3	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	32°46'9"N, 97°26'29"W	Edit Unavailabilities
C-130E 2	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	32°46'9"N, 97°26'29"W	Edit Unavailabilities
C-130E 1	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	32°46'9"N, 97°26'29"W	Edit Unavailabilities
C-130E 5	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	33°37'16"N, 84°21'57"W	Edit Unavailabilities
C-130E 3	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	33°37'16"N, 84°21'57"W	Edit Unavailabilities
C-130E 4	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	33°37'16"N, 84°21'57"W	Edit Unavailabilities
C-130E 2	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	33°37'16"N, 84°21'57"W	Edit Unavailabilities
C-130E 1	0 mph	0.0	C-130E	6	344.1 mph	1,150.8 mi.	33°37'16"N, 84°21'57"W	Edit Unavailabilities

Figure 9: C130 aircraft attributes

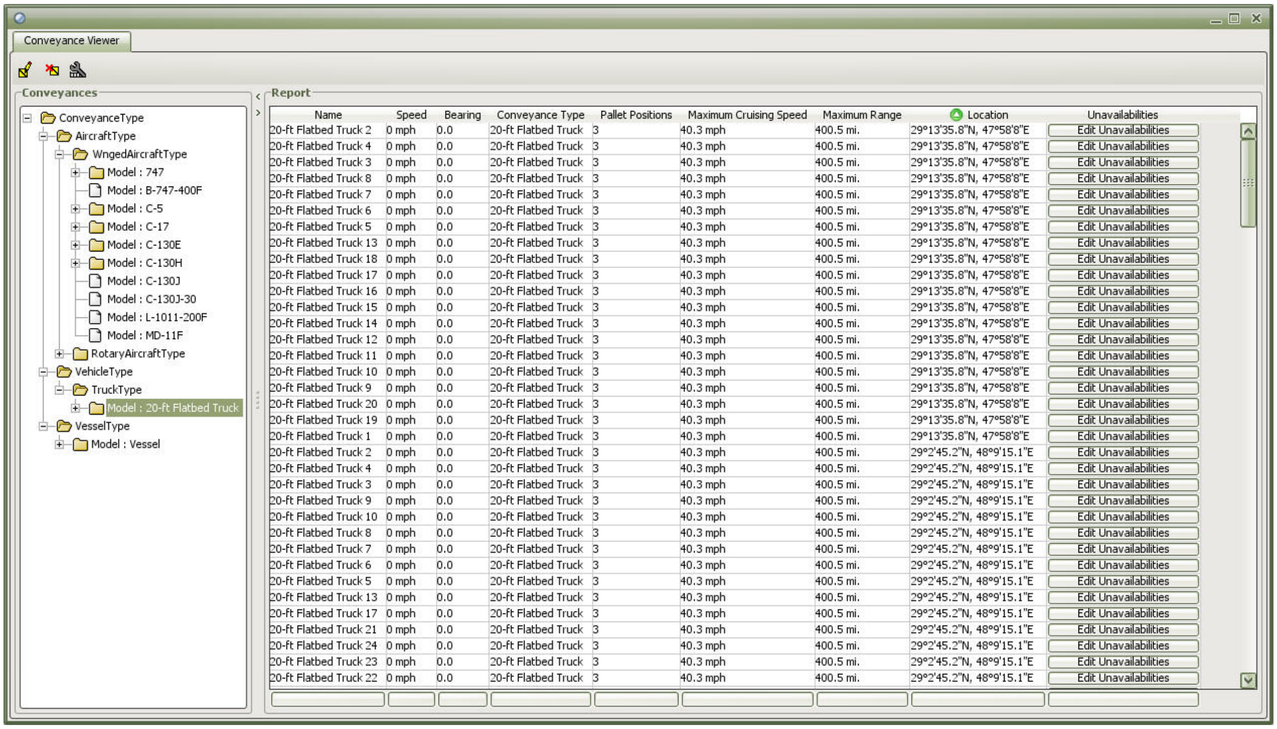


Figure 10: Truck convoy attributes

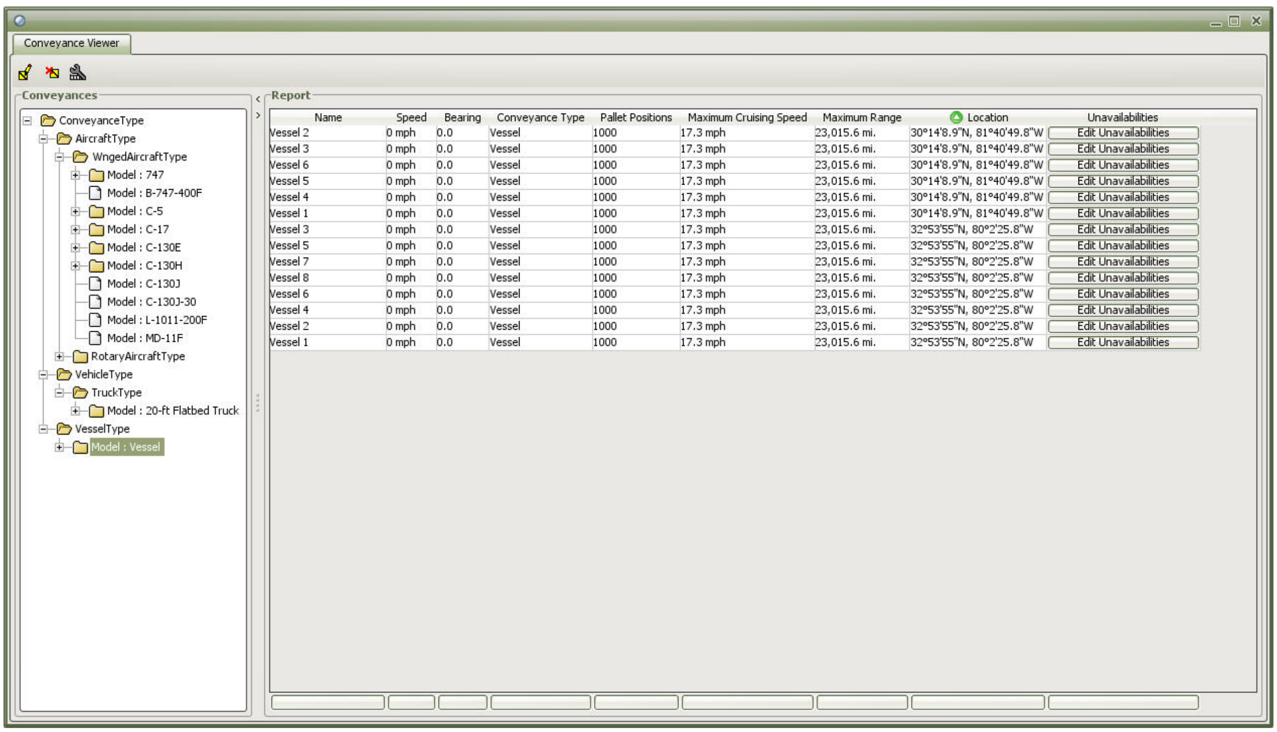


Figure 11: Typical ship attributes

A typical request for *add on armor* is shown in Figure 12. It requires deliver to Al Udeid, with a *high* priority and an earliest and latest time for delivery window of 25 to 31 December 2005.

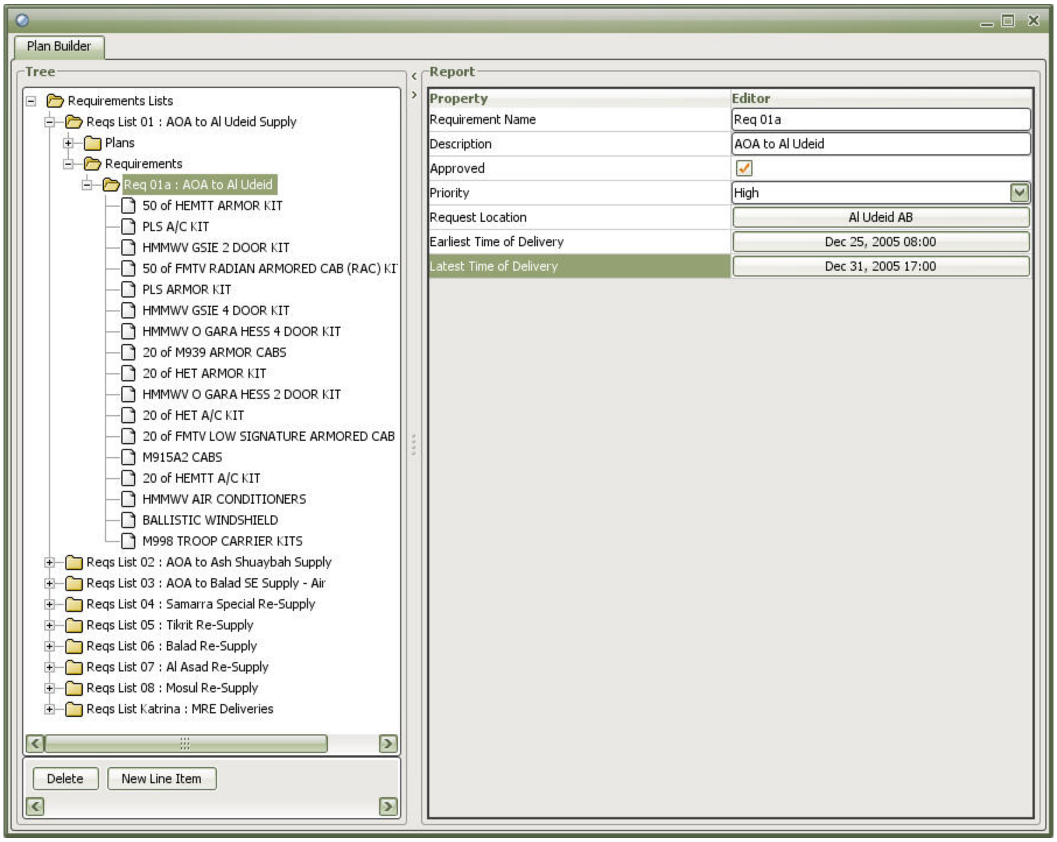


Figure 12: Add-on-Armor (AOR) request for delivery to Al Udeid

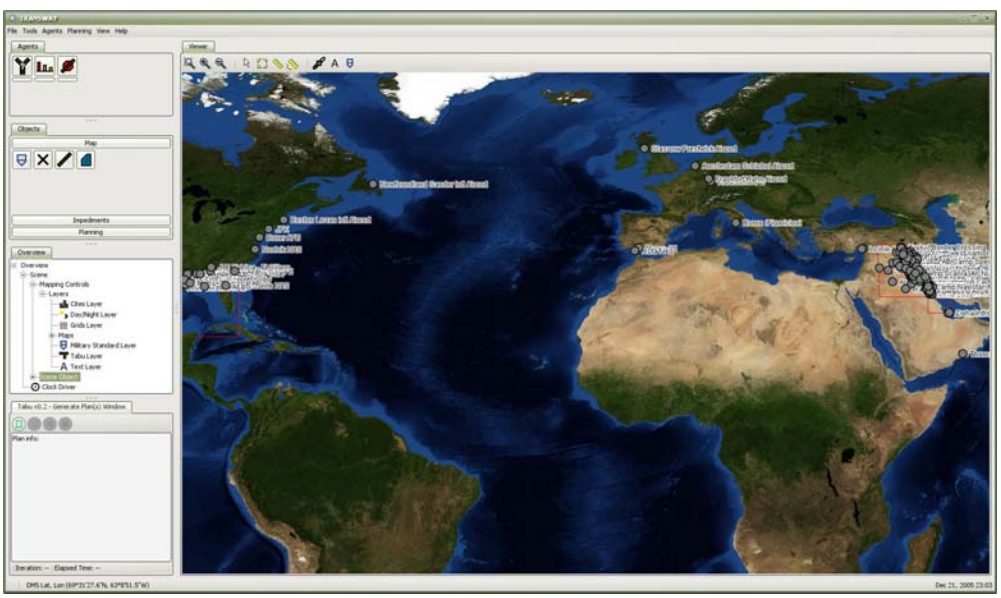


Figure 13: User zooms in on map to reduce clutter

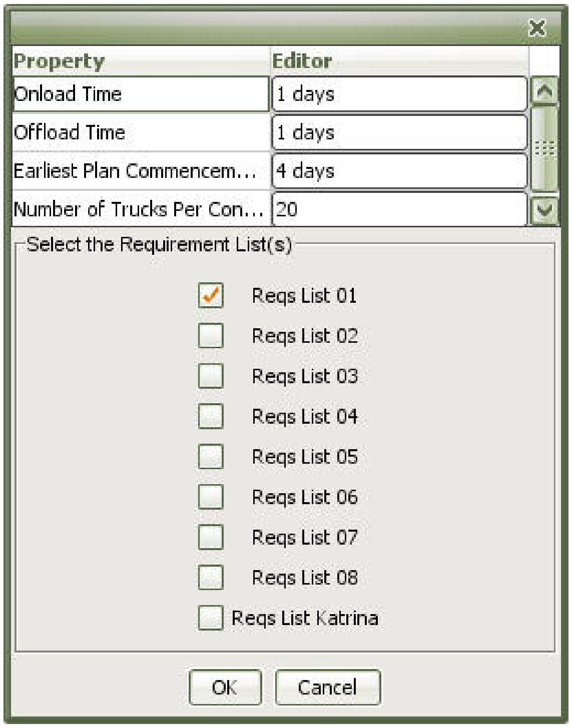


Figure 14: Tabu agent interface

Figure 15: Control of search duration

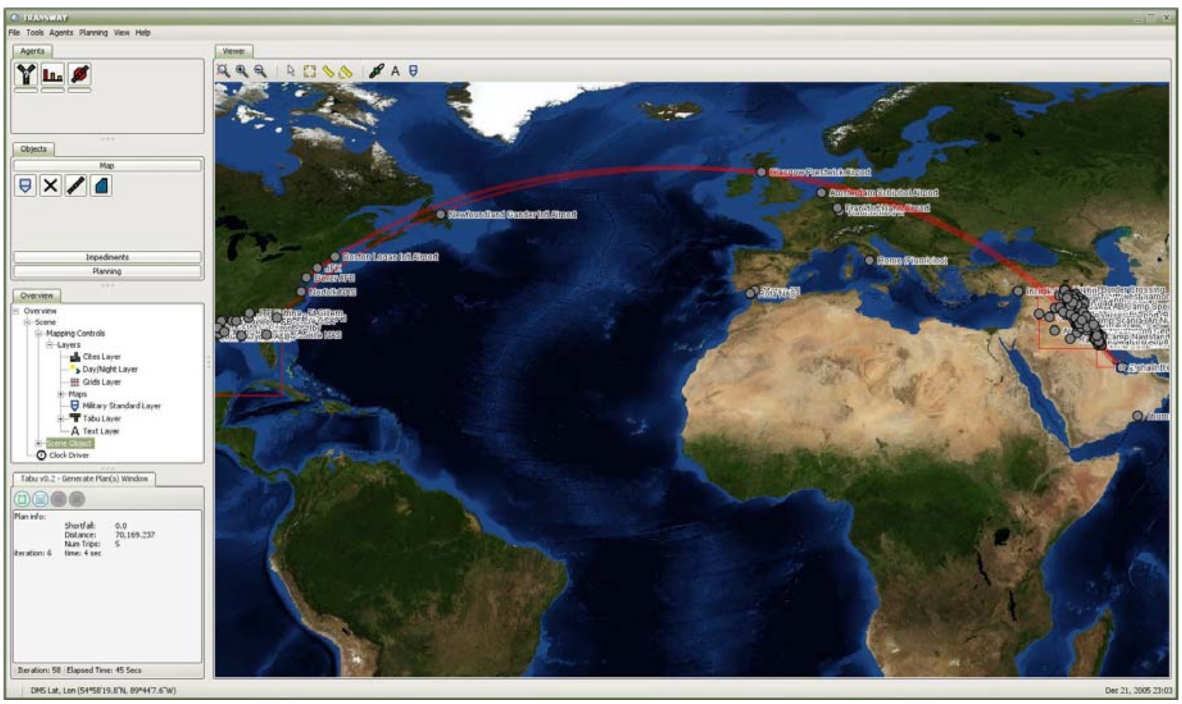


Figure 16: Completed first plan showing routes

To fulfill the request for the shipment of *add-on-armor* to Al Udeid (Figure 12) the user activates the Tabu agent and selects the appropriate *requirement* from the displayed Requirement Lists (Figure 14). In this case the Al Udeid *requirement* is Requirement List 1. Since the Tabu agent has the ability to continue its search for optimum delivery plan even after it has found a way of satisfying the *requirement*, the user has the option of either setting a maximum time for the planning activity (Figure 15) or allowing the agent to continue until all alternatives have been explored. Of course it is not expected that the user would ever want to wait for that length of time and therefore the option for the user to simply stop the agent is available. In future versions of TRANSWAY, particularly if the Tabu agent were to be implemented in an opportunistic mode (i.e., in a manner that would activate the planning process without user involvement as soon as the conditions on which an existing plan were originally based have changed), it would be a relatively simple matter to restrict the extensiveness of the search for an optimum plan. For example, the search could be automatically aborted if after either a specified period of time or a given number of generated plans no better plan has been found.

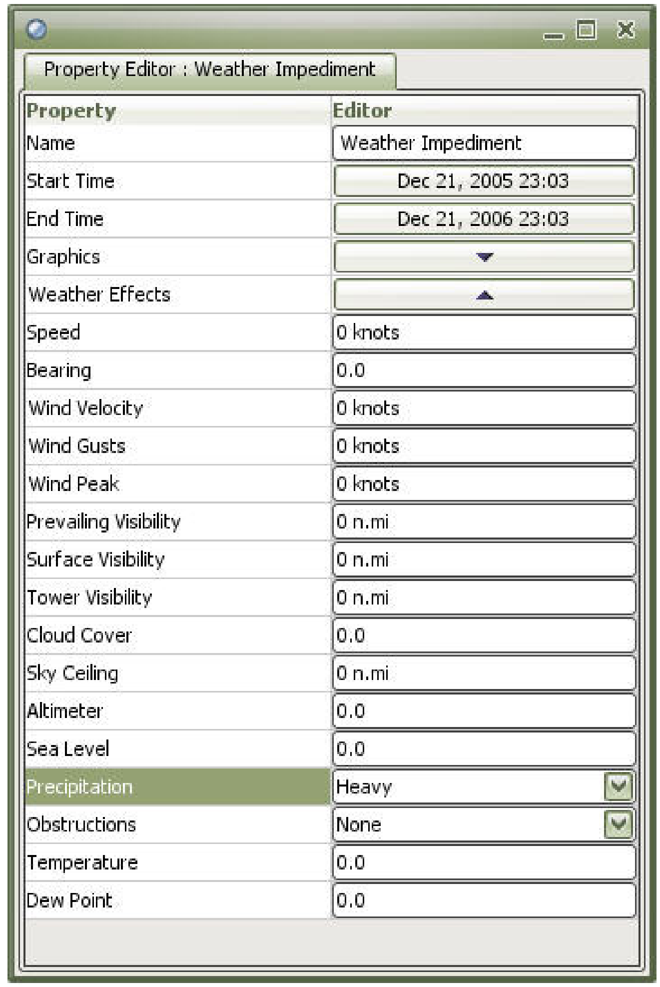


Figure 3.17: Weather impediment

Figure 17: Weather Implement

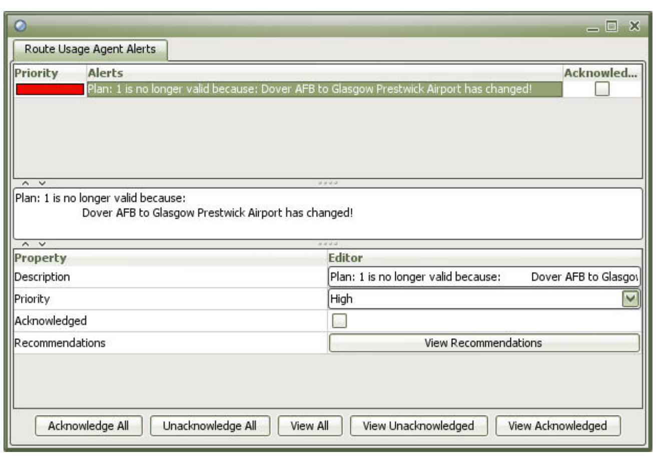


Figure 18: Impediment agent alert

For the completed plan the route is shown in Figure 16 by means of a red line. Next the user enters an impediment in the form of an adverse weather report that essentially eliminates Glasgow as a refueling stop (Figure 17). Immediately, the Impediment agent alerts the user and suggests that re-planning is in order (Figure 18). Again, also in the case of impediments, this first version of TRANSWAY provides only one type of generic impediment (i.e., a weather condition), with the objective of demonstrating the kinds of causes that would require re-planning that could be easily implemented in subsequent versions of the system, based on user preferences and priorities.

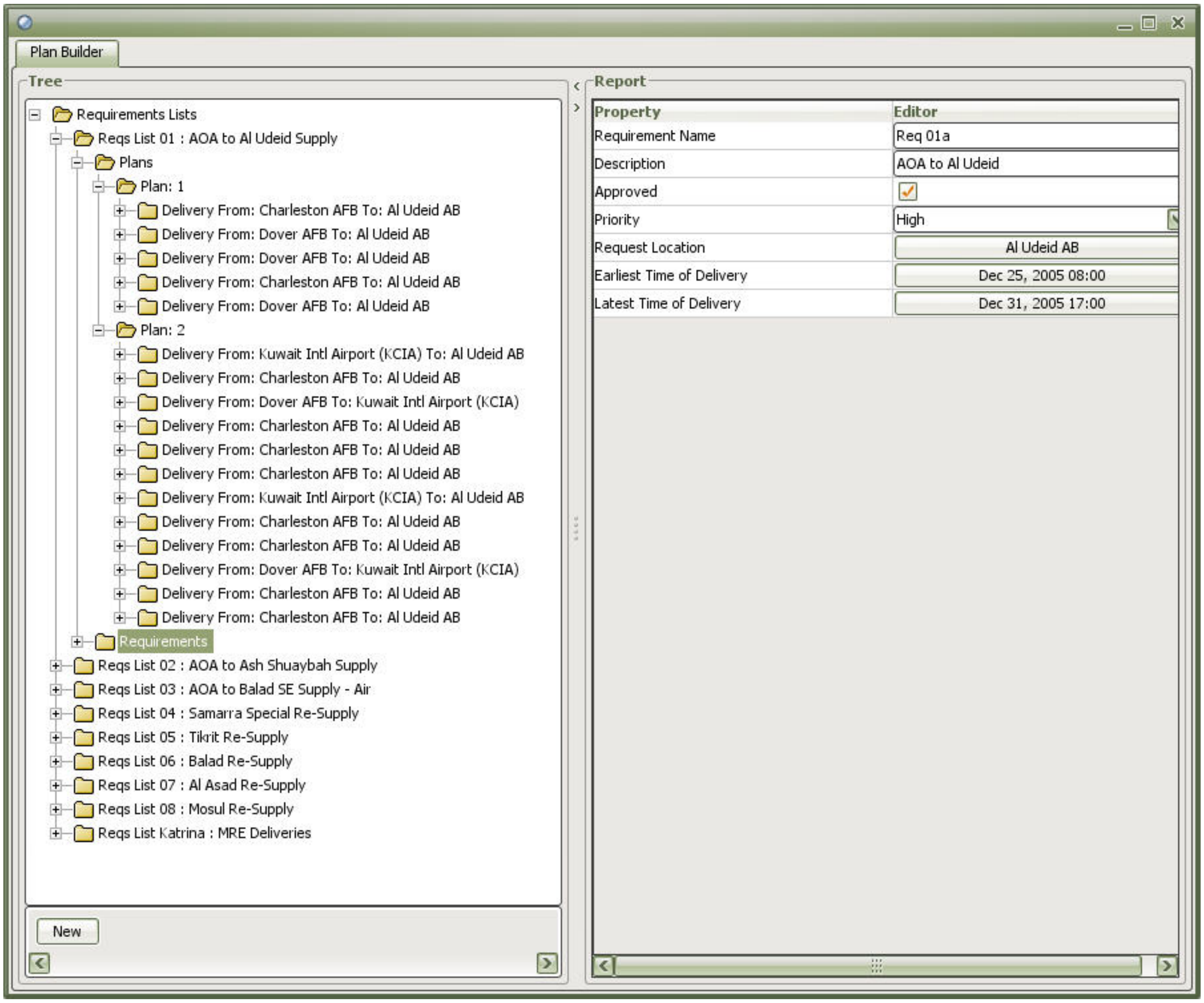


Figure 19: Summary of deliveries for the first and second plans

To initiate a re-planning action the user proceeds in the same manner as described previously for the generation of the first plan (Figures 14 to 16). The user will notice that during the generation of each plan the routes that are being explored by the Tabu agent are dynamically indicated on the map display. Temporarily displayed green lines indicate drop-off points that are being considered. Red lines indicate actual delivery routes with the thickness of the red line providing a proportional indication of the volume of supplies being transported along that particular route. Summary lists of the deliveries involved in both plans are shown in Figure 19.

Even thought this first test-bed version of TRANSWAY is purposely limited in scope it does allow the user to explore the details of each delivery plan (i.e., start and end locations, conveyances and routes used, start and end times, and duration of each trip), as shown in Figures 20 to 23.

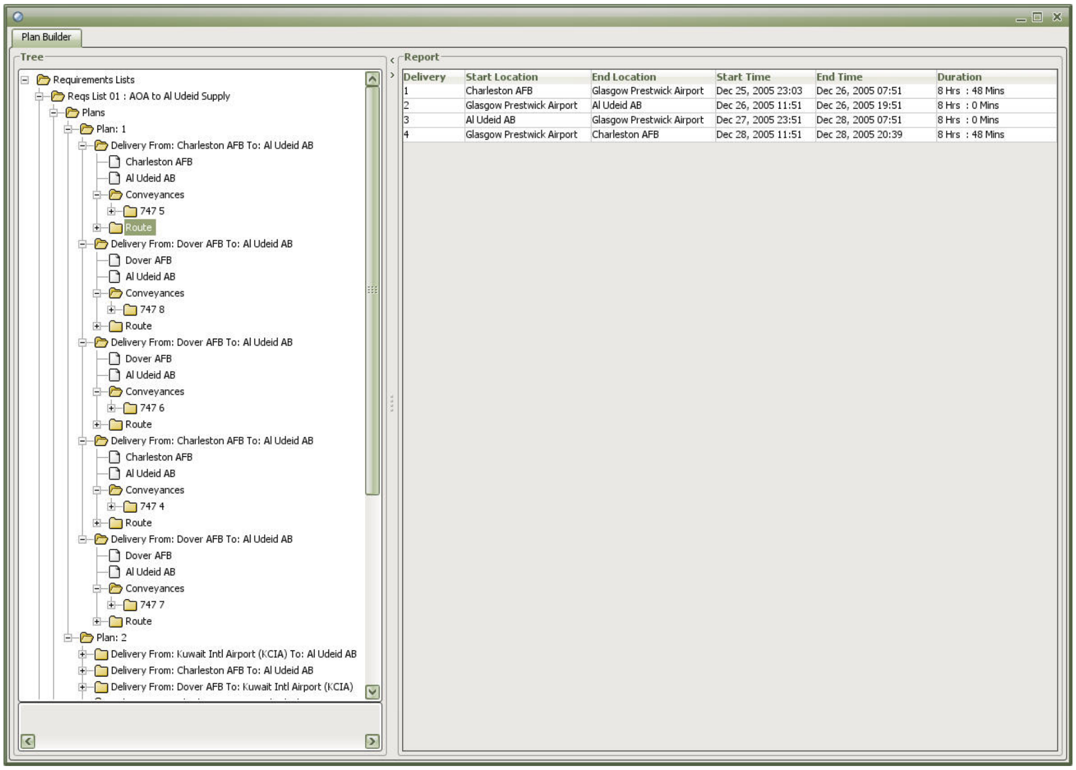


Figure 20: Typical drill-down details of the first plan

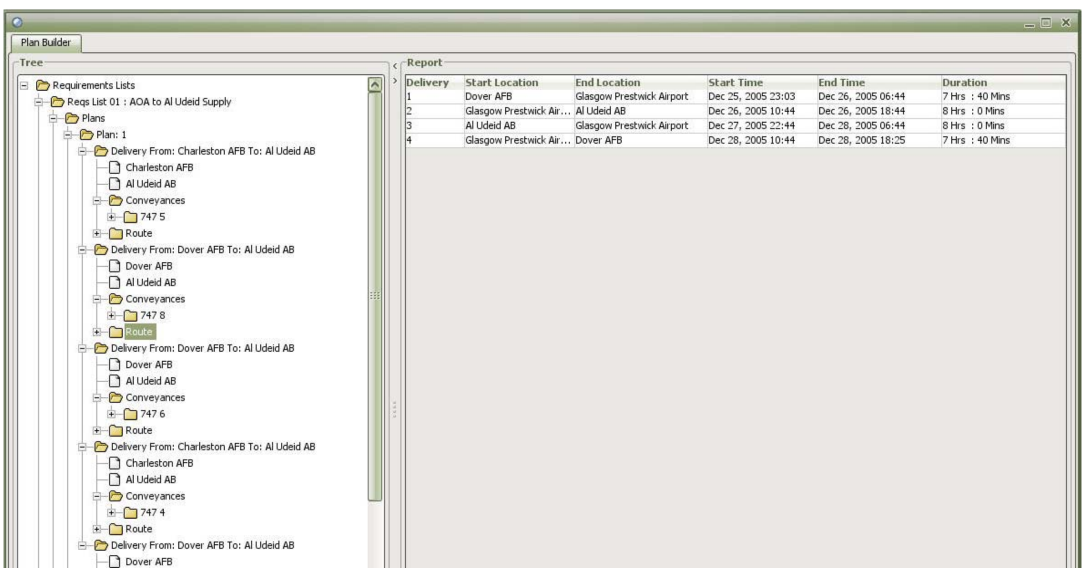


Figure 21: Typical drill-down details of the first plan

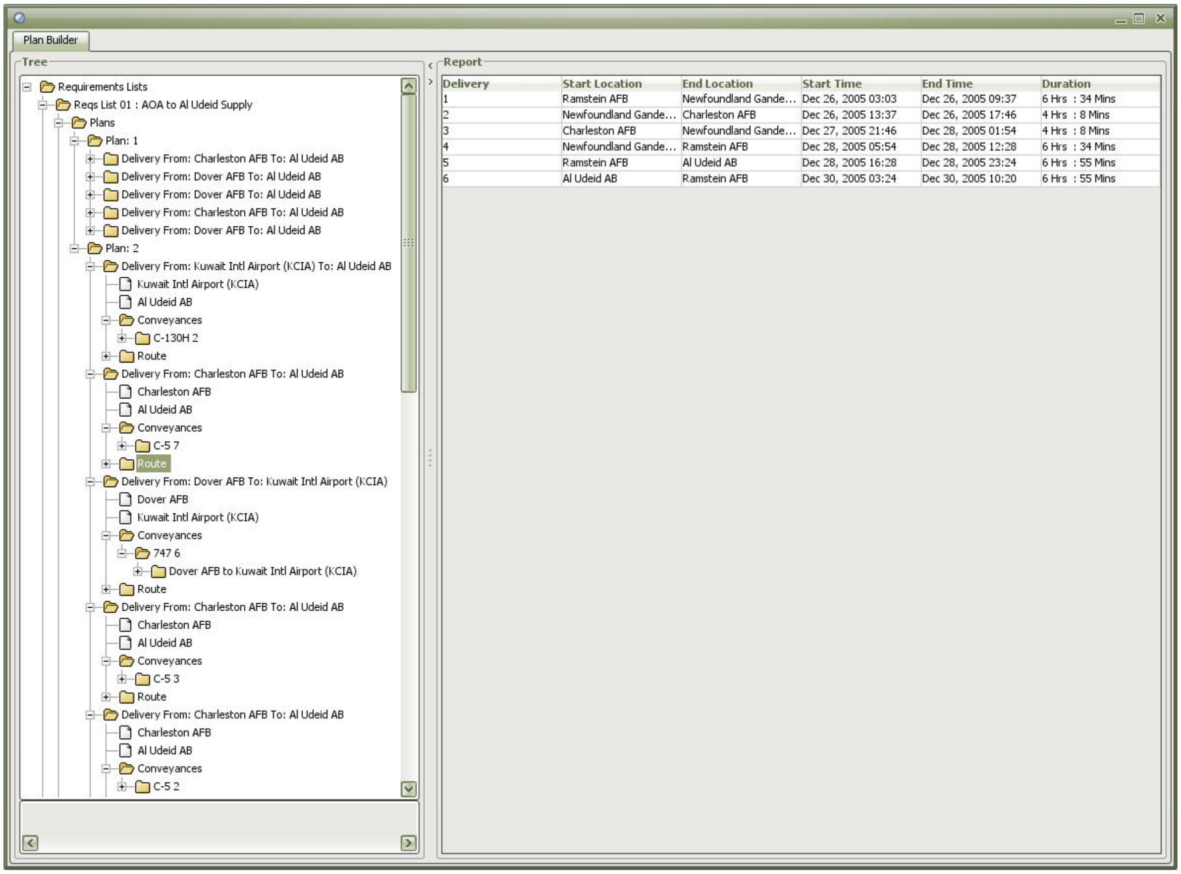


Figure 22: Typical drill-down details of the second plan

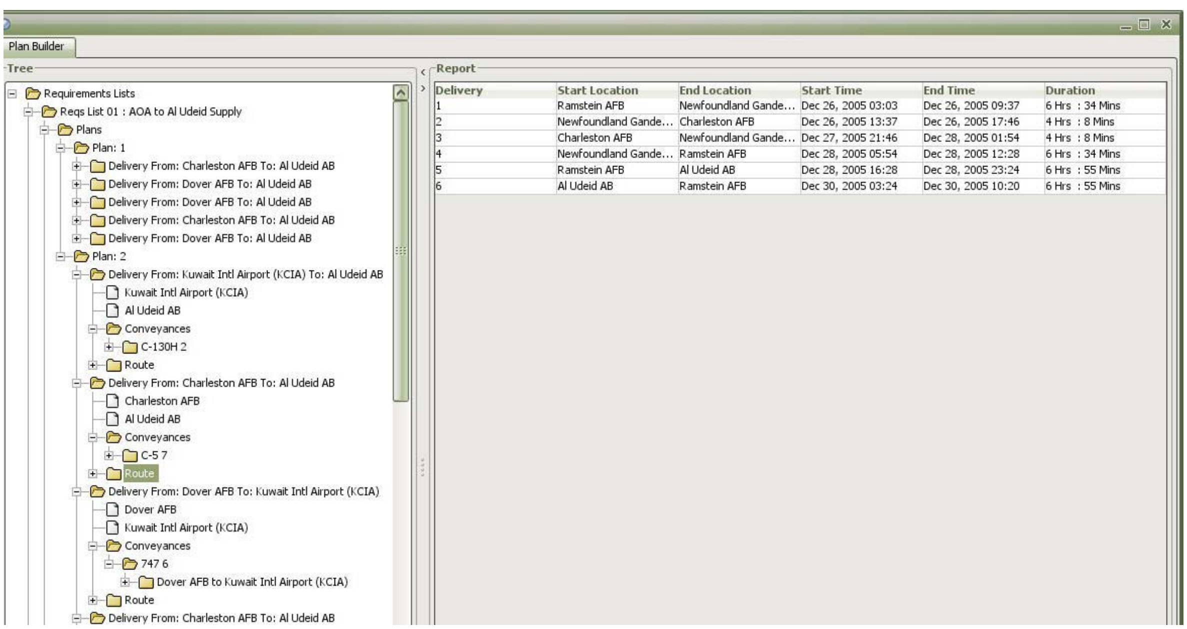


Figure 23: Typical drill-down details of the second plan

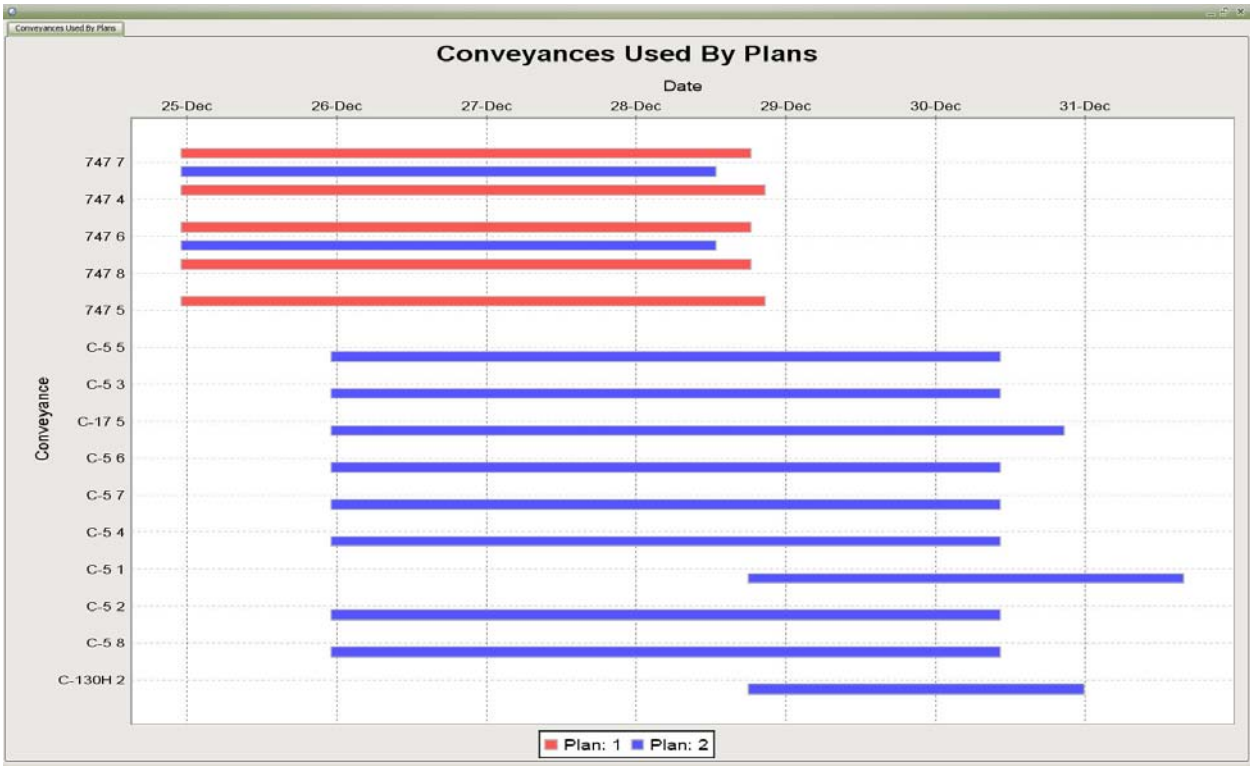


Figure 24: Comparison of conveyances needed in support of the first and second plans

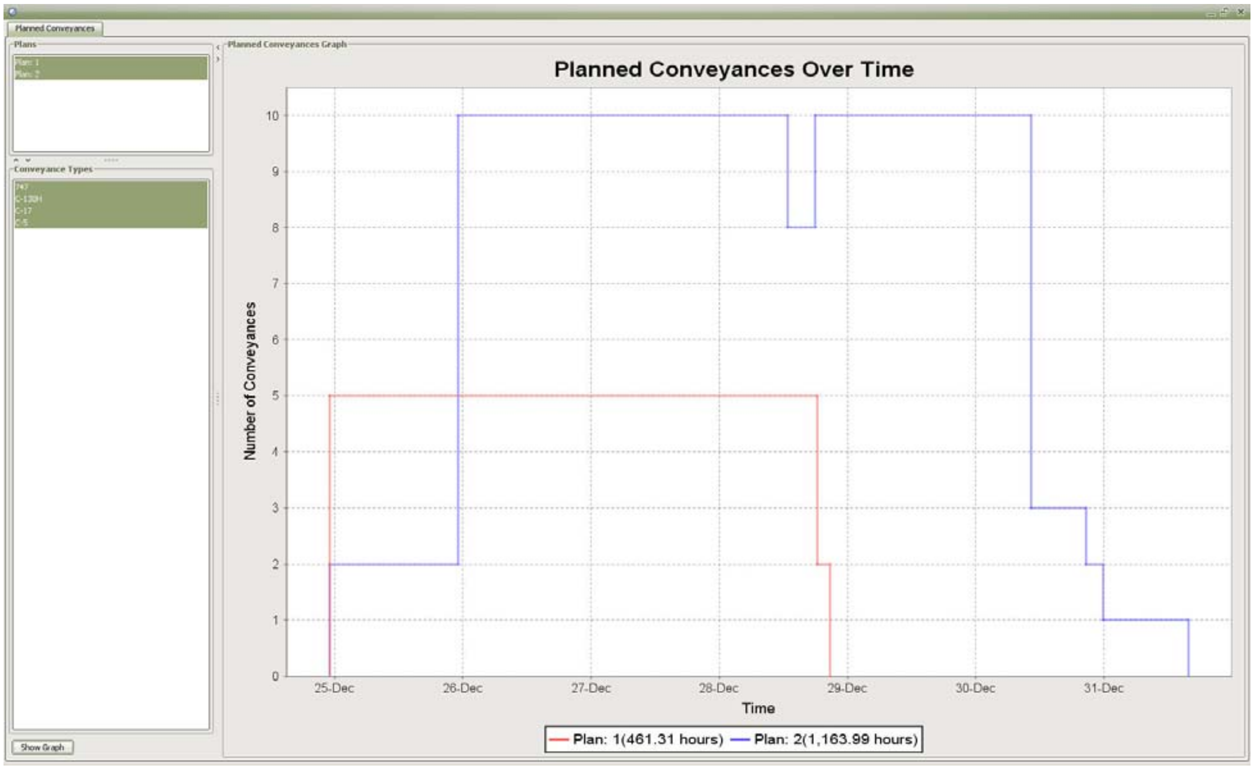


Figure 25: Comparison of overall lift requirements for the first and second plans

Apart from the ability of the user to drill down into the details of each delivery plan there are a number of comparative graphical reports available, such as the utilization of specific conveyances by each plan shown in Figure 24 and the number of conveyances that are required to support each plan over time shown in Figure 25.

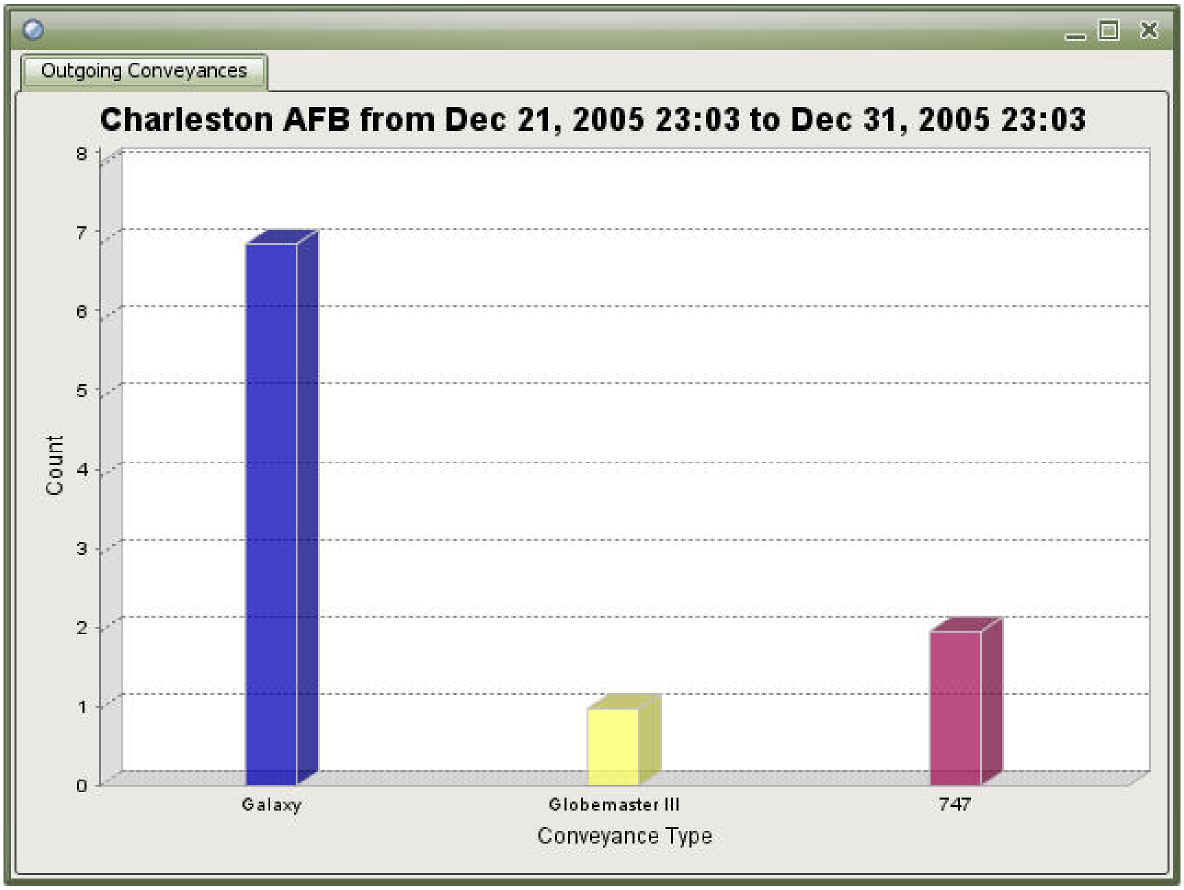


Figure 26: Departures from Charleston by conveyance type

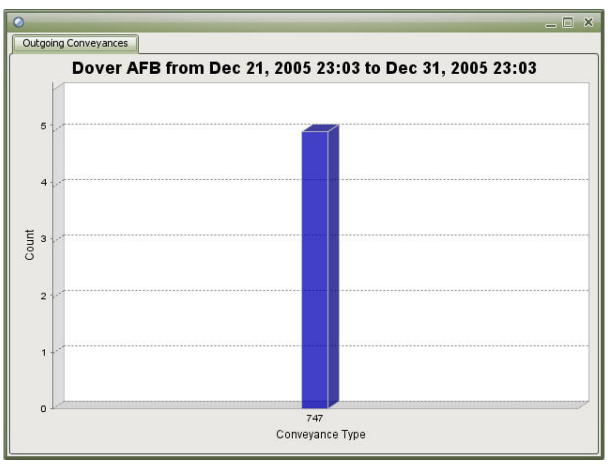


Figure 27: Departures from Dover

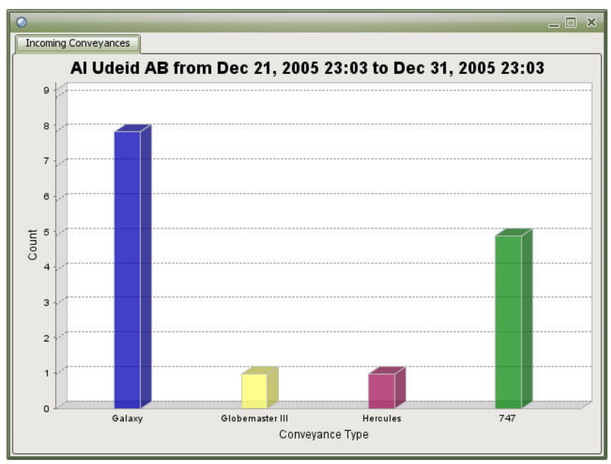


Figure 28: Departures from Al Udeid

Figures 26 to 28 show examples of conveyance departures from the Charleston, Dover and Al Udeid APODs, respectively. Similar reports are available for cargo transfers by date (Figures 29 to 30) in terms of what was lifted yesterday, the current inventory, and what is planned to be lifted during the next 72 hours. In this way the user is able to determine the expected volume of shipments from any particular APOD on a daily basis. The dates selected for the example bar chart reports shown in Figures 29 and 30 are December 23 to 26, 2005.

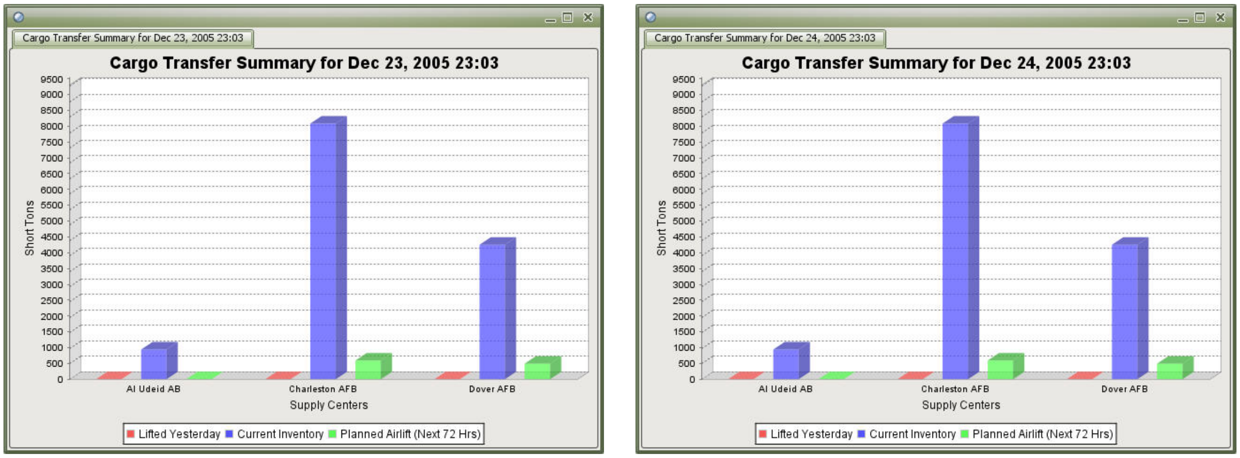


Figure 29: Typical cargo transfer history, status, and 72-hour projections

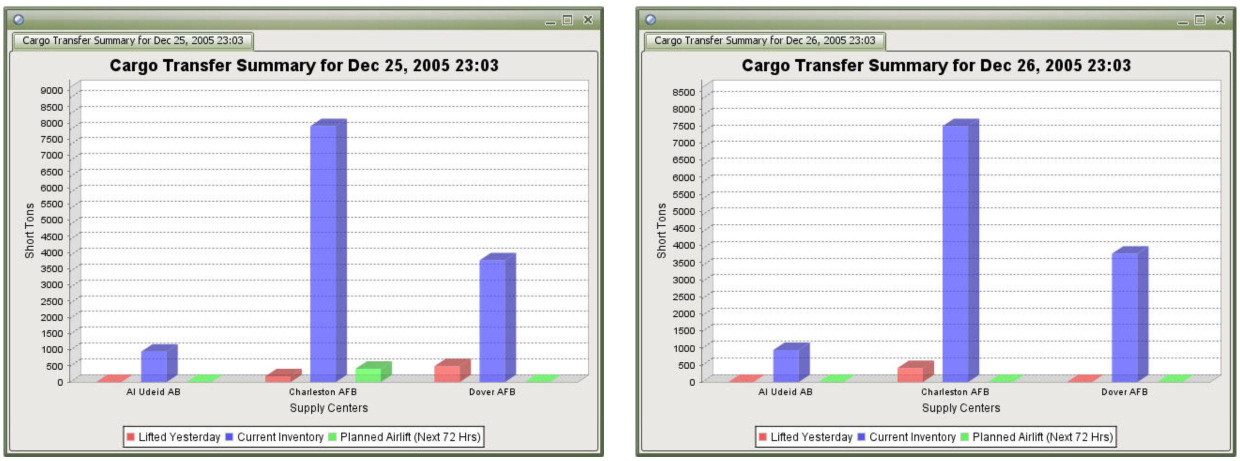


Figure 30: Typical cargo transfer history, status, and 72-hour projections

Again, these reports are intended to be examples of the kind of information that can be made available by TRANSWAY. The development team will be guided by feedback from users in future development cycles. The reporting capabilities of the system can be easily extended in any direction within the constraints of data availability.

Integration with SM21 Web Portal

It is planned to integrate TRANSWAY with the SM21 Web Portal that is being developed by other SM21 Project team members (i.e., Steve Carson).

The TRANSWAY Toolsets in an Experimental Exercise

The proposed experimental demonstration of the SM21 Project follows a demonstration of the concepts of an Efficient Marine Terminal (EMT) and Agile Port System (APS) that was conducted at the Port of Tacoma, Washington, in 2003 within the context of a commercial-public transportation environment. EMT represented the marine terminal component of a postulated Efficient Marine/Rail Intermodal Interface (EMRII) system. The demonstration suggested that full implementation of the EMRII concepts and associated processes could conceivably achieve operating cost savings of approximately 40%.

The purpose of the SM21 demonstration planned for sometime during the first half of 2007 is to validate the findings of the 2003 demonstration with a full-scale implementation of the entire EMRII system. Specifically, it is proposed to utilize an integrated SM21 system platform in support of the deployment of a Brigade Combat Team from Fort Lewis to the Port of Tacoma through the commercial-public transportation corridor. The demonstration objectives include:

- Explore the integration requirements of military, commercial, and public transportation needs and expectations within the constraints of a commercial-public transportation corridor.
- Address the ability of a marine terminal to accommodate military load-out operations while minimizing disruption to commercial operations.
- Minimize the area of terminal real estate required during ship loading operations by reducing the total staging area requirement to no more than two acres.
- Conduct the military deployment operations through a commercial terminal in parallel with commercial container ship unloading and loading operations.
- Provide the ability to plan, track, and dynamically re-plan the force deployment from the garrison to the port.

As stated in the after-action report of the 2003 demonstration, it is proposed to: "…to construct and demonstrate a dynamic force deployment execution process planning that allows for dynamic re-planning of the PPP (Power Projection Platform) to strategic port movement of forces …" (Savacool 2006).

The Exercise Scenario

It is proposed to move an Army Brigade Combat Team (BCT), comprising approximately 3,000 soldiers with their organic equipment assets, from Ft. Lewis to the Port of Tacoma. Since Ft Lewis is located less than 20 miles from the Port, the movement will utilize truck convoys. The objective of the exercise is to accomplish this military movement as expeditiously and efficiently as possible with minimum disruption of vehicular traffic in the public transportation corridor and minimum impact on normal commercial port operations. Efficiencies and economies are expected to be achieved by:

A. Utilizing to the extent possible commercial-of-the-shelf (COTS) and government-of-the-shelf (GOTS) software, integrated to facilitate the flow of data and thereby ensure the availability of a common operational picture throughout the exercise. This will require the seamless exchange of data between multiple software systems during the movement.

B. Integrating existing military data feeds (e.g., TCAIMS-II) into the data flow, so that the data used in the SM21 system environment are compatible with and representative of standard military logistic data. This will require the fusion of data received from separate military and commercial sources.

C. Emphasizing pre-execution planning through early examination of data, anticipation of problem areas and potential failure points, and the development of contingency plans.

D. Considering the vehicular traffic patterns in the affected portions of the public-commercial traffic corridor during the earliest planning stages.

E. Considering the potential influence of the movement on the normal commercial port activities, and vice versa, during the earliest planning stages.

F. Having available intelligent re-planning tools that will allow operators to prepare alternative plans in near real-time when unforeseen events occur during the execution phase.

G. Reducing the marshalling yard footprint(s) required at Ft Lewis and at the Port of Tacoma, to the extent possible.

H. Considering the loading sequence of the ship(s) at the port during planning of the marshalling yard(s) at Ft Lewis, the order of trucks and convoys, and the staging of equipment at the Port.

I. Maintaining in-transit visibility throughout the movement from the marshalling yard(s) at Fort Lewis to the final location of the equipment and supplies on-board ship.

J. Planning and executing concurrent ship loading operations at the Port, so that the loading time will be reduced through parallel loading operations performed by multiple Stevedore gangs on the same ship.

K. Increasing the load-planning efficiency of truck and ship conveyances in terms of decreased plan preparation time, reduced human resource requirements, and superior storage space utilization.

L. Increasing the security and force protection aspects of the movement through better planning, tighter control of processes, continuous monitoring and in-transit visibility, and faster reaction to unforeseen events.

The exercise is planned to be conducted under real world conditions during an actual force deployment, with normal coordination and controlling roles played by the military chain of command, the operational personnel of the Army's Surface Deployment and Distribution Command (SDDC)[1], civilian supervisory port personnel, and local law enforcement authorities.

[1] The Surface Deployment and Distribution Command (SDDC) serves concurrently as a subordinate command of the Army and a component command of USTRANSCOM.

Applying the Capabilities of the TRANSWAY Toolset

Utilizing the interoperability between TRANSWAY and the Integrated Computerized Deployment System (ICODES), both TRANSWAY and ICODES will be employed as an integrated adaptive toolset during the proposed SM21 exercise. The capabilities of this integrated toolset are described in more detail in a previous SM21 report entitled: "Adaptive Software for Simulation Demonstration Support" submitted in early October 2006. In summary, the principal capabilities will be applied in the following functional areas:

- Exchanging data with several existing military data feeds (i.e., TCAIMS-II, WPS, IBS (receiving only), and MDSS-II).
- Preparing objectified spatial representations of marshalling yards, conveyances, and transportation routes (within a geo-spatial reference frame).
- Preparing staging plans and conveyance load-plans, with consideration of data integrity, storage area accessibility, hazardous material requirements, and trim and stability concerns in the case of ships only.
- Planning of delivery routes involving roads, seaways, and air channels.
- Rapidly re-planning load-plans and delivery plans in near real-time under emergency and extenuating circumstances.
- Merging cargo list changes received from military data feeds with existing cargo data, on a continuous basis throughout the conduct of the exercise.
- Exporting the cargo data contained in final load-plans to military systems through the same data feeds that were previously employed to import cargo data into ICODES.

These capabilities are available to be utilized within the integrated SM21 software environment during the exercise in support of the following operational sequences and functional activities:

1. Importing an initial cargo list from the TCAIMS-II, WPS or MDSS-II military data feeds.
2. Validating the integrity and completeness of the imported cargo list by comparison with multiple reference libraries.
3. Preparing an objectified spatial representation of the marshalling yards at Ft Lewis and at the Port of Tacoma.
4. Preparing cargo staging plans for the marshalling yards at Ft Lewis and the Port of Tacoma.
5. Capturing data pertaining to cargo with PDAs utilizing barcode scanning devices in (secure) wireless communication environments.
6. Preparing an objectified spatial representation of one or more types of trucks.
7. Preparing load-plans for trucks and truck convoys.
8. Preparing delivery plans for the movement of truck convoys from Ft Lewis to the Port of Tacoma.

9. Re-planning delivery routes in case of events that require alternative delivery plans.
10. Preparing load-plans for the embarkation of cargo onto ships.
11. Re-planning loads on conveyances during execution in case of events that require alternative load-plans.
12. Merging cargo data imported from external military data feeds with existing cargo data in the SM21 system environment.
13. Exporting final load-plan data from the SM21 system environment to military systems via TCAIMS-II, WPS or MDSS-II.
14. Providing visual access to load-plan information throughout the exercise via web-based user-interfaces.
15. Providing geo-spatial mapping capabilities for the visualization of infrastructure and routes from a global view down to street level detail.

References:

Savacool E. (2006); 'Military Agile Port Demonstration Preplanning Overview'; CCDoTT Report, California State University, Long Beach, California, June 28.

TRANSWAY Data Dictionary

TRANSWAY Name	Type	Data Domain	TRANSWAY Description
Person/ Passenger:			
SSN	string	Any string	Social security number of person who is required to be loaded onto a conveyance as a passenger.
lastName	string	Any string	Last name of passenger.
firstName	string	Any string	First name of passenger.
middleName	string	Any string	Middle name of passenger.
dateOfBirth	integer	numeric	Date of birth of passenger.
bloodType	enumeration	APOS, BPOS, ABPOS, and OPOS	Blood type of passenger.
gender	enumeration	male, female, unknown	The adjusted height of the parent for a particular association as a result of taking the dimensions of the children.
height	float	numeric	Height of passenger in inches (in).
weight	float	numeric	Weight of passenger in pounds (lb).
Alerts:			
type	enumeration	General, supply shortfall, conveyance shortfall, plan invalid	Type of alert provided by an agent.
priority	enumeration	Low, medium, high	Priority of the alert generated by an agent.
summaryMessage	string	Any string	Explanatory message generated by agent in conjunction with an alert.
acknowledged	boolean	Acknowledgement (true/false)	Status of acknowledgement of agent alert by user.
Node:			
type	enumeration	SSA, POD, APOD, SPOD, POE, APOE, SPOE	Node type.

earliestAllowableTransportDeparture	integer	numeric	Earliest time at which conveyance is able or authorized to depart.
latestAllowableTransportDeparture	integer	numeric	Latest time at which conveyance is able to depart to meet future deadlines.
MOGw	integer	numeric	Maximum on ground – working (maximum number of aircraft that can be loaded or unloaded at a particular APOD/E at any one time).
MOGp	integer	numeric	Maximum on ground – parking (maximum number of aircraft that can be parked at a particular APOD/E at any one time).
throughput	float	numeric	Quantity of cargo that can be moved out of the node in pounds per hour (lb/hr).
fuelQuantity	float	numeric	Amount of fuel holding capacity.
holdingCapacity	float	numeric	Amount of cargo that can be stored at node.
Route:			
routeType	enumeration	paved road, unpaved road, air channel, water channel	Type of air or surface route.
length	float	numeric	Length of route (or route leg) in nautical miles (nm).
locationA	float	Struct	Location of start node of route in terms of latitude/longitude/altitude.
locationB	float	Struct	Location of end node of route in terms of latitude/longitude/altitude.
Impediment:			
type	enumeration	unknown, weather, attack, explosion	Type of impediment (however, only the weather impediment is implemented in Version 1.0).
degree	enumeration	Low, medium, high	Overall severity of impediment.
precipitation	enumeration	none, hail, snow	Type of precipitation impediment.
obstructions	enumeration	None, light, moderate, heavy	Degree of obstruction due to impediment.
duration	float	numeric	Time period during which the impediment is in effect in hours (hr).

speed	float	numeric	Speed at which weather front is moving in nautical miles (nm).
bearing	float	numeric	Direction in which weather front is moving.
Conveyance:			
position	float	Struct	Position of conveyance in terms of latitude/longitude/altitude.
speed	float	numeric	Current speed of conveyance in knots (kph).
range	float	numeric	Total distance conveyance can travel regardless of refueling need.
homeLocation	float	Struct	Conveyance home base in terms of latitude/longitude/altitude.
loadTime	float	numeric	Standard time to load conveyance.
unloadTime	float	numeric	Standard time to unload conveyance.
maxWeigthCapacity	float	numeric	Maximum weight conveyance can operate with.
maxPalletCapacity	float	numeric	Maximum number of pallets that can be loaded onto conveyance.
type	enumeration	truck, vessel, rotary, winged, rail	Type of conveyance (however, rail is not implemented in Version 1.0).
inflightRefuel	boolean	capable (true/false)	Whether aircraft conveyance can be refueled in flight.
length	float	numeric	Maximum standard length of conveyance in inches (in).
width	float	numeric	Maximum standard width of conveyance in inches (in).
height.	float	numeric	Maximum standard height of conveyance in inches (in).
weight	float	numeric	Maximum standard weight of unloaded conveyance.
fuelConsumption	float	numeric	Fuel consumption of conveyance at cruising speed.

location	float	Struct	Current location of conveyance in terms of latitude/longitude/altitude.
maxContainer	integer	numeric	Maximum number of containers that can be loaded onto conveyance.
militaryCivilian	enumeration	military, civilian	Whether conveyance has military or civilian ownership.
crewSize	integer	numeric	Number of persons needed to operate conveyance.
unrefueledRange	float	numeric	Maximum standard distance conveyance can travel without refueling.
<u>Cargo:</u>			
supplyClass	enumeration	I, II, II, III, IV, V, VI, VII, VIII, IX	Supply Class (however, only Classes I, V, and IX (partial) are implemented in Version 1.0).
unitMeasure	enumeration	Each, box, case	Packaging configuration of the cargo item.
packageQuantiy	integer	numeric	Number of items per package.
length	float	numeric	Maximum length of package in inches (in).
width	float	numeric	Maximum width of package in inches (in).
height	float	numeric	Maximum height of package in inches (in).
weight	float	numeric	Maximum weight of package in pounds (lb).
NSN	string	Any string (13 characters)	National Stock Number.
commodityCode	string	Any string	Commodity code of cargo item.
<u>Requirement/Request for Supples:</u>			
cargoList	(n/a)	(n/a)	List of requested types of supply items.
quantity	integer	numeric	Quantity of each type of supply item requested.

locationDestination	float	Struct	Location of delivery destination in terms of latitude/longitude/altitude.
ETA	integer	numeric	Earliest Time of Arrival at delivery destination.
LTA	integer	numeric	Latest Time of Arrival at delivery destination.
priority	enumeration	Low, medium, high	Priority assigned to request for supplies.
Pallet:			
location	float	Struct	Current location of pallet in terms of latitude/longitude/altitude.
type	enumeration	463L, standard wood, factory wood	Type of pallet (however, only the 463L pallet type is implemented in Version 1.0).
quantity	integer	numeric	Quantity of this type of pallet available at the location.
totalWeight	float	numeric	Holding capacity of pallet in pounds (lb).
totalHeight	float	numeric	Maximum allowable height of pallet and contents in inches (in).
palletCondition	enumeration	serviceable, repairable, unusable	Condition of pallet.
length	float	numeric	Maximum length of pallet in inches (in).
width	float	numeric	Maximum width of pallet in inches (in).
height	float	numeric	Maximum height of empty pallet in inches (in).
weight	float	numeric	Maximum weight of empty pallet in pounds (lb).
weightNetting	float	numeric	Maximum weight of netting and tie downs in pounds (lb).
volume	float	numeric	Maximum volume of pallet and contents in cubic feet (cf).
stackingHeight	integer	numeric	Maximum number of pallets that can be stacked.

numberContainer	integer	numeric	Maximum number of pallets allowed in a container.
Container:			
location	float	Struct	Current location of container in terms of latitude/longitude/altitude.
type	enumeration	Standard, dry, rack, reefer	Type of container.
quantity	integer	numeric	Quantity of this type of container available at the location.
totalWeight	float	numeric	Holding capacity of container in pounds (lb).
containerCondition	enumeration	serviceable, repairable, unusable	Condition of container.
lengthOS	float	numeric	Maximum external length of container in inches (in).
widthOS	float	numeric	Maximum external width of container in inches (in).
heightOS	float	numeric	Maximum external height of container in inches (in).
weight	float	numeric	Maximum weight of empty container in pounds (lb).
volumeOS	float	numeric	Maximum external volume of container in cubic feet (cf).
volumeHolding	float	numeric	Maximum internal volume of container in cubic feet (cf).
lengthHolding	integer	numeric	Maximum internal length of container in inches (in).
widthHolding	float	numeric	Maximum internall width of container in inches (in).
heightHolding	float	numeric	Maximum internall height of container in inches (in).
stackingHeight	integer	numeric	Maximum number of containers that can be stacked.